

PAGE

**Tyson's Site**  
**Montgomery County, Pennsylvania**

**Off-Site Operable Unit Remedial  
Investigation Report**

**Volume I**

**July 29, 1987**

Prepared For  
**CIBA-GEIGY Corporation**  
**Ardley, New York**

Prepared By  
**Environmental Resources Management, Inc.**  
**West Chester, Pennsylvania**

**AR300001**

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CIBA-GEIGY

29 July 1987

Tim Travers  
Project Manager  
SARA Special Sites Section  
U.S. Environmental Protection Agency  
Region III  
841 Chestnut Bldg.  
Philadelphia, PA 19107

Dear Mr. Travers:

Attached please find the Off-Site Remedial Investigation Report for the Tyson's Site. This RI is submitted as of July 29, 1987, as you requested. The Endangerment Assessment will be provided tomorrow morning.

With reference to your letter of June 24, 1987, we take exception to the implication that submission of the RI has been dilatory. The principal reason for the need for deferral in submission of the RI has been requests by EPA and NOAA for additional Tasks previously approved by EPA. These additional tasks include sediment sampling in the floodplain and the river, verification of river water quality to parts per trillion levels, additional bioassays using methods which required confirmation by NOAA and EPA. We wished to comply with these requests and to produce a quality work product as we know the Agency would expect.

We will be providing the document to J. Snyder, PA DER.

Sincerely,

*Karlina Tierney*  
Karlina Tierney

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## EXECUTIVE SUMMARY

Tyson's Site is an abandoned septic waste and chemical waste disposal site reported to have operated from 1962 to 1970 within a sandstone quarry. The site is located in Upper Merion Township, Montgomery County, Pennsylvania. The approximate four acre plot which constitutes a series of former unlined lagoons was owned and operated from 1960 to 1969 by companies owned by Franklin P. Tyson and by Fast Pollution Treatment, Inc. The stock of this corporation was owned by the current owner of the land, General Devices, Inc. ("GDI"), and by Franklin P. Tyson. GDI was active in the management of Fast Pollution Control, Inc. The site was used for disposal of liquid septic tank waste and sludges and chemical wastes which were hauled to the site in bulk tank trucks. The Pennsylvania Department of Environmental Resources (PA DER) ordered the site owners to close the facility in 1973. During closure, the lagoons were reported to be emptied, backfilled, vegetated, and the contents transported off-site.

Between January 1983 and August of 1985, EPA and its subcontractors conducted a series of investigations primarily in what is now referred to as the On-Site Area. The On-Site Area is defined here as that area south of the railroad tracks and within or immediately adjacent to the security fence erected during the emergency response measures. On 9 January 1985, EPA issued its Record of Decision (ROD) for the On-Site Area which recommended

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excavation of the materials in the former lagoons and off-site disposal of these materials.

In the fall of 1985, CIBA-GEIGY Corporation agreed to conduct a further investigation of the Off-Site Area, the need for which was described in the 9 January 1985 ROD. The Off-Site Area is defined here as that area outside of the security fence including the deep aquifer (bedrock aquifer). EPA subdivided the Off-Site Area into five sub-areas or "operable units". Although the EPA terminology "operable unit" is used throughout this report, it does not imply that each operable unit is independent of the other units of the On-Site Area with regards to overall potential risk or remediation of the site. The Off-Site Operable Units include the following:

- Deep Aquifer (Operable Unit 1)
- Hillside Area (Operable Unit 2)
- Railroad Area (Operable Unit 3)
- Floodplain/Wetlands (Operable Unit 4)
- Seep Area (Operable Unit 5)

On 27 May 1986, an Administrative Consent Order (ACO) was signed for the Off-Site Operable Unit RI/FS. Details on the work to be conducted as part of the Off-Site Operable Unit RI/FS are presented in the Work Plan and the first and second addendums to the Work Plan submitted to EPA 300015 Off-Site Operable Unit RI

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Report includes details on all of the tasks originally described in the Work Plan attached to the ACO and in the addendums to the Work Plan, except for the wells on the north side of the river which will be submitted to EPA upon completion of their installation and ground water sampling.

The investigation of the Deep Aquifer included the installation of thirty-three nested bedrock monitoring wells at twelve locations, hydrologic field testing including slug tests and step drawdown tests, the collection of one round of ground water samples from all bedrock wells and previously installed and accessible EPA wells, a long term (seven-day) pump test, a dense non-aqueous phase liquid (DNAPL) recovery test, and a well inventory of residential, commercial, industrial, and public supply water wells within a three-mile radius of the site. In addition to these tasks, several rounds of river sediment and bottom water samples were collected from numerous locations in the Schuylkill River.

The purpose of the Hillside Investigation was to determine if overflow in the former lagoon area had resulted in contamination of soils on the hillside between the lagoons and the railroad tracks. The Hillside Investigation consisted of the collection of soil samples from eight locations along the hillside and one background sample.

A subsurface soil investigation was conducted in the Railroad Area and was designed to determine if recorded seepage and runoff from the former lagoon area had contaminated the soil and ballast beneath the railroad tracks. In this effort, a total of twenty-eight soil samples were obtained from soil borings

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advanced to bedrock at ten locations along the railroad tracks. A soil gas analysis of vapor samples taken from shallow boreholes along the sides of the railroad tracks was also conducted to better determine the extent of contamination in this area.

An investigation of the Floodplain/Wetlands Area located between the former lagoon area and the Schuylkill River was conducted to obtain information on the extent and severity of contamination in this area and its potential effect on biota. This investigation included the following subtasks: field reconnaissance, collection of environmental samples, determination of the environmental mobility of organic constituents, bioaccumulation studies, acute and chronic bioassays, and sediment toxicity bioassays.

Investigation of the Seep Area was conducted to determine the nature and extent of any contamination which may exist in this area. For this investigation, seven test pits were excavated and sixteen soil samples were collected from this area. The investigation of the Seep Area also included a review of historical aerial photographs to determine past land usage in this area. Chemical analyses obtained during earlier investigations by EPA contractors were also procured.

Although several of the Off-Site Operable Units are discussed individually and the entire Off-Site Area separately from the On-Site Area, there is a strong interrelationship among several of the Off-Site Units and the former lagoons. Additional discussion of the relationship among the former lagoons, the Deep Aquifer and the Floodplain/Wetlands Areas can be found in a previous response to EPA's Focused Feasibility Study (FFS) for

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the On-Site Area by CIBA-GEIGY's Consultants (September 1986) and the Comprehensive Feasibility Study submitted to EPA (June 16, 1987; ERM).

Preliminary conclusions presented in the response to EPA's FFS with regard to the site hydrogeology have been confirmed by the results of the Off-Site Operable Unit RI as follows:

- previous investigations have incorrectly characterized the hydrogeologic setting at the site,
- there is no on-site "surficial aquifer",
- EPA has separated the site into on-site/off-site areas ignoring the comprehensive and interrelated nature of the problem and the need to define it at this level prior to proper evaluation and selection of an appropriate remedial alternative,
- virtually all of the present source of residual contamination is in the underlying and off-site bedrock occurring both as a dense non-aqueous phase liquid (DNAPL) in the bedrock and as a dissolved phase derived from the DNAPL in the ground water.

Conclusions based upon the results of this RI for each of the Operable Units are as follows:

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**Deep Aquifer (Operable Unit 1)**

- the deep aquifer (bedrock flow system) between the former lagoons and the Schuylkill River is contaminated;
- the deep aquifer contamination exists in two forms: a dense non-aqueous phase liquid (DNAPL) and a dissolved phase derived from the DNAPL;
- DNAPL most probably entered the bedrock system via direct infiltration from the former lagoons which were situated directly on or in the highly weathered and fractured bedrock, and/or via the seeps along the bedrock outcrop north of the lagoons into the very permeable railroad ballast, with subsequent infiltration into the bedrock beneath the tracks;
- once in bedrock, the DNAPL flowed along the weathered bedding planes and fracture zones in the Lower Stockton Formation, and coated and penetrated the walls of the fractures and bedding planes;
- the DNAPL has migrated through the deep aquifer as far as the south bank of the Schuylkill River to depths as great as 140 feet, the extent of migration is currently under investigation;
- there is no evidence (nor would we expect based upon site hydrogeologic conditions) that the DNAPL is discharging via the deep aquifer directly to the river;

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- at this site attempts to recover DNAPL by known recovery methods have been shown to be ineffective due to the physical and chemical nature of the DNAPL, attempts to recover DNAPL from bedrock elsewhere have also been shown to be ineffective (Feenstra and Cherry, 1986);
- presence of residual DNAPL will continue to generate a dissolved phase contamination in the deep aquifer;
- the present source of ground water contamination to the deep aquifer is the dissolution (dissolved phase) of the DNAPL in the bedrock;
- the overall contribution of the four major DNAPL constituents (1,2,3-trichloropropane, xylenes, toluene, and ethylbenzene) via the contaminated lagoon soils is only about 3.7 percent of the total contaminant mass in ground water. On the other hand, about 96.3 percent of the contamination in the deep (bedrock) aquifer results from the DNAPL present in the deep aquifer;
- the monitoring well yields in the deep aquifer at the site are low (generally less than 1 gpm) and decrease with depth;
- the direction of ground water flow in the deep aquifer is northward towards the river;

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- there is an upward flow gradient in the deep aquifer underlying the floodplain, as expected in the floodplain and ground water discharge zone associated with a major regional drainageway;
- this gradient shows that both the ground water and dissolved phase contamination is discharging to the river within the regional ground water flow system;
- field evidence shows that the bedrock flow system discharges to the floodplain deposits, however, the discharge rate is significantly less than the ground water flow rate within the deposits in the floodplain. This is indicated by the lack of detectable organic compounds in the wells completed in the floodplain deposits;

#### Schuylkill River

- low concentrations of site specific organic compounds were detected in three river sediment samples taken directly opposite the site;
- this contamination may be a result of ground water discharge (dissolved phase contaminants) or of direct runoff from the drainageways discharging through the Off-Site Area, including the discharges from the EPA installed air stripper;

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- a suite of non-site related polycyclic aromatic hydrocarbons (PAHs) was detected in most of the sediment samples both upriver and downriver of the site and at far greater concentrations than those contaminants identified as originating from the former lagoons;
- the PAHs are a result of the ubiquitous distribution of coal fines washed downriver and deposited along the Schuylkill River floodplain from coal crushing/washing and storage piles along the northern reaches of the river;
- there are three water treatment plant intakes on the Schuylkill River downriver of the Tyson's Site; PA American Water Company in Norristown about 2000 feet from the site and the Philadelphia Water Department intakes at the Belmont and Queen Lane treatment plants;
- confirming historical data, part per trillion concentrations of 1,2,3-trichloropropane were detected in both raw and treated water samples taken at all of the treatment plants and at the Bartram Park sampling station downriver of the Philadelphia intakes;
- apparently the existing treatment systems do not remove the 1,2,3-trichloropropane from the untreated water at the part per trillion level;

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- the probable source of 1,2,3-trichloropropane in the river is contaminated ground water discharging from the deep aquifer to the river in the vicinity of the site.

Hillside Area (Operable Unit 2)

- compounds detected in the former lagoons were detected at trace levels in several of the samples collected in this area and indicate that overland flow and/or shallow ground water discharge from the fractured bedrock outcrop in this area occurred during operation of the lagoons;
- the total volume of contaminated soil in the Hillside Area is minimal with depth to bedrock usually being one or two feet and with exposed bedrock present in much of the area.

Railroad Area (Operable Unit 3)

- a wide variety of organic and inorganic compounds were found throughout this area, both associated with the former lagoon areas and with the materials used for the railroad ballast, railroad construction, and transport of materials by the railroad.

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Floodplain/Wetlands Area (Operable Unit 4)

- trace levels of site-related contaminants were detected in the ditches and drainageways receiving runoff from the site and discharge from the EPA installed air stripper;
- PAHs, which are not site related, are generally found at the highest concentrations of all organic compounds detected and with the greatest distribution;
- the source of the PAHs is most probably the coal fines which have been washed downriver and deposited on the floodplain;
- non-site related trace level concentrations of PCBs and the pesticides DDD, DDE, and DDT were found at several locations in the floodplain;
- PCB-1260 was the only constituent confirmed in the species analyzed during the bioaccumulation study (no site-related compounds were confidently detected); since PCBs are environmentally ubiquitous, it would be unusual if two to ten year old aquatic animals did not accumulate them in their tissues;
- no acute or chronic effects were observed in the fish species studied; the results of the testing in Daphnia were inconclusive;

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- results of the liquid phase elutriate chemical analysis and bioassay show no potential acute toxicity in Daphnia in the sediments studied;
- based on the results of the 10-day ecological study of sediment leachate effects on survival in Daphnia and analysis of leachate, a decrease in Daphnia reproduction in leachates generated from the sediments from the west swamp and DDT area may be due to metabolites of non-site related DDT; and
- no adverse effects on any organisms investigated during the biological studies could be attributed to site-related constituents.

Seep Area (Operable Unit 5)

- eleven of the sixteen samples taken from this area had no detectable Hazardous Substance List (HSL) organic compounds. The highest single concentration of HSL organics detected consisted of non-site related PAHs,
- the origin of the seep remains unknown, but is probably related to shallow ground water flow in this area; the seep has not re-occurred since initial restoration of the area.

SECTION

1

SECTION 1

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## SECTION 1

### INTRODUCTION

#### 1.1 Site Description

Tyson's Site is an abandoned septic waste and chemical waste disposal site reported to have operated from 1962 to 1970 within a sandstone quarry. The site is located in Upper Merion Township, Montgomery County, Pennsylvania (Figure 1-1). The approximate 4-acre plot which constitutes a series of former unlined lagoons, is bordered on the east and west by unnamed tributaries to the Schuylkill River, a steep quarry high-wall to the south, and a Conrail railroad switching yard to the north (Plate 1). North of the Conrail tracks is the Schuylkill River floodplain. The area of the former lagoons lies above the 100-year floodplain.

The sandstone quarry was excavated along the face of an east-west trending ridge into weathered bedrock, forming two, bowl-like depressions. This excavation can be described as a large eastern pit with a dominating 60-foot highwall and a less well-defined western excavation consisting of a series of low benches with a highwall to the south of between 10 and 40 feet.

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## 1.2 Site History and Regulatory Action

### 1.2.1 Site Operation and Closure

From 1960 to 1970, the site was owned and operated by companies owned by Franklin P. Tyson and Fast Pollution Treatment, Inc. The stock of this corporation was owned by the current owner of the land, General Devices, Inc. (GDI), and by Franklin P. Tyson. GDI was active in the management of Fast Pollution Treatment, Inc. The site was used for disposal of liquid septic tank waste and sludges and chemical wastes which were hauled to the site in bulk tank trucks. It appears that as the lagoons were filled with wastes and subsequently covered, new lagoons were created. Figure 1-2 shows the locations of the former lagoons as interpreted from 1965 and 1973 aerial photographs of the area. In 1969, the property was purchased from Fast Pollution Treatment, Inc. by GDI. The Pennsylvania Department of Environmental Resources (PA DER) ordered the site owners, GDI, to close the facility in 1973. During closure, the lagoons were reported to be emptied of standing water, backfilled, vegetated, and the contents transported off site.

### 1.2.2 EPA Emergency Response Team (ERT) - Preliminary Investigation

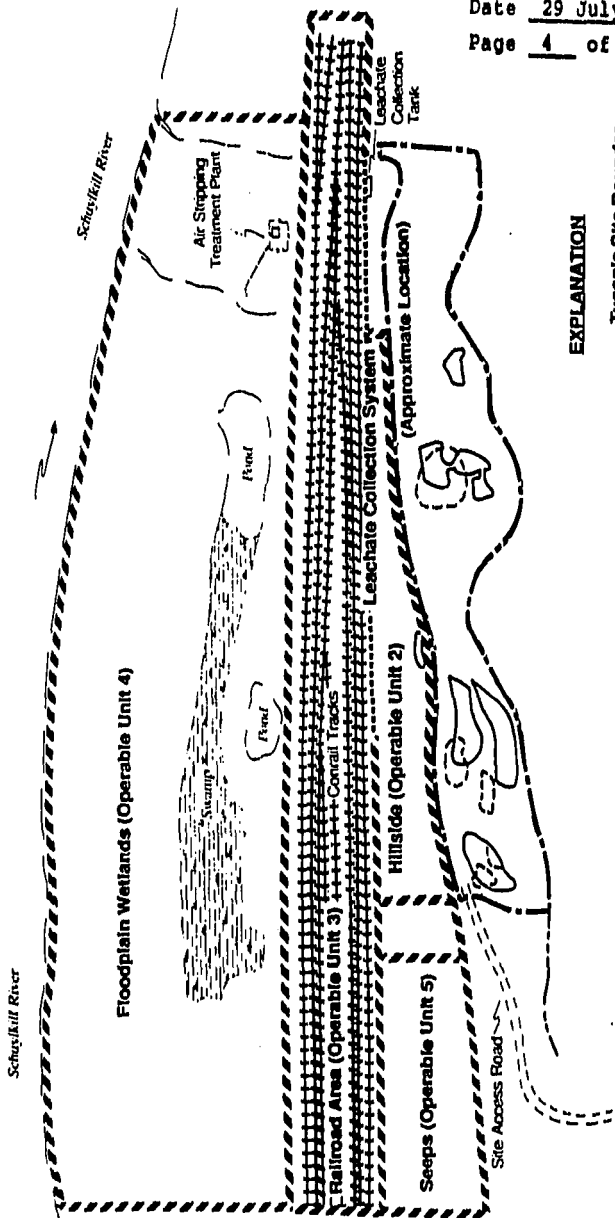
In response to an anonymous citizen complaint, the EPA Emergency Response Team (ERT) conducted a preliminary investigation of Tyson's Site in January 1983. This investigation included the

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**Figure 1-2  
Off-Site Operable Units  
Tyson's Site**



**EXPLANATION**

- Tyson's Site Boundary
- Approximate Location of Leachate Collection System

0 100  
Scale in Feet



NOTE: Deep Aquifer Includes Area From Background Area to Schuylkill River.



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collection of a number of environmental samples between the period of January and April, 1983. The samples included surface waters, soils, and ground water, the latter being from an undescribed number of wells installed during this preliminary investigation (labeled ERT on Plate 1). The results of this investigation are reported in the "Remedial Action Master Plan and Remedial Investigation/Feasibility Study Work Plan" (NUS, July 1983). As noted, locations for all of these samples were not known and therefore cannot be reported.

### 1.2.3 EPA Immediate Removal Actions

Subsequent to the ERT investigation, it was determined that immediate measures would be required to reduce possible exposure by uncontrolled chemical odors and liquid waste releases from the unsecured site. The following immediate removal actions were initiated by EPA Region III Environmental Emergency Branch in March, 1983 (where appropriate, they are shown on Plate 1):

- Erection of a security fence
- Construction of a leachate collection system to reduce contaminant discharges to the Schuylkill River and to reduce organic vapor emissions
- Construction of an air stripping/leachate treatment system for removing volatile organic compounds from the collected leachate

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- Installation of an activated carbon air exhaust system to remove organics from the air stripper
- Limited soil capping of the former lagoons and hydroseeding
- Regrading to divert uncontaminated runoff from the former lagoon areas
- Field investigation to determine the extent and magnitude of contamination and to determine the need for additional remedial measures

As part of the immediate removal actions, EPA Region III installed and sampled seven monitoring wells. Five of the wells were installed in the overburden materials within and downgradient of the lagoons. The two remaining wells were installed to bedrock, but were not situated to permit an assessment of downgradient ground water quality in the bedrock flow system beneath the site area. The results of this phase of work are also given in the "Remedial Action Master Plan and Remedial Investigation/Feasibility Study Work Plan" (NUS, July 1983).

#### 1.2.4 On-Site Investigations

Following conduct of the initial field investigation and immediate removal actions, the Remedial Action Master Plan (RAMP) and work plan were prepared and approved in September, 1983. At the same time, funding for the Remedial Investigation (RI) and

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the Feasibility Study (FS) was also approved. Under subcontract to NUS Corporation, Michael Baker, Jr., Inc. conducted the RI (henceforth termed the On-Site RI) from December, 1983 through March, 1984. The RI included ambient air monitoring, sampling of surface soils, surface water, sediment, and ground water; a geophysical survey of proposed test boring locations; installation of additional monitoring wells; and collection of subsurface materials. Although the majority of this effort was centered on the On-Site area (within the security fence), many surface soil, water, and sediment samples were taken in the floodplain area and along the railroad tracks. None of the wells installed during this investigation were completed in bedrock. The findings and conclusions of this investigation are given in the "Remedial Investigation Report and Feasibility Study Work Plan for Tyson's Dump Site, Montgomery County, Pennsylvania" (Baker/TSA, August 1984). A summary of the analytical results obtained during this investigation is given in Appendix A. Plate 1 shows the locations of all wells installed during the preliminary investigation and the On-Site RI.

Also in August, 1984, Michael Baker, Jr., Inc. submitted its draft FS report based upon the results and conclusions of the RI (Feasibility Study Report, NUS, August 1984). On January 9, 1985 EPA, Region III submitted its Record of Decision (ROD) for the Tyson's Site. The ROD outlined the EPA's selected remedial actions which included the following:

- Excavation and off-site disposal of residual contaminated soils and wastes to a permitted Resource Conservation and Recovery Act (RCRA) landfill

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- Upgrading the existing air-stripping facility
- Excavation and off-site disposal of contaminated sediments within the tributary which receives effluent from the existing air stripper

EPA's ROD was limited to alternatives for the On-Site Area, the existing air stripping facility, and contamination resulting from discharges from the EPA installed air stripper. With regard to the Off-Site area (defined henceforth as the area outside of the security fence), it was determined that additional investigations would be required.

In August, 1985, SRW Associates Inc. submitted its 30 percent design for the EPA chosen alternative. In the same month, Woodward-Clyde Consultants filed their report on an investigation conducted for EPA in the lagoon area. The Woodward-Clyde investigation included additional borings throughout the lagoon area to better determine the volume of material to be excavated. A summary of the analysis of the soil samples obtained during this investigation is given in Appendix B along with a map of the soil boring locations. Further information on the procedures, results, and conclusions of this investigation are given in "Supplemental Site Assessment, Tyson's Dump Superfund Site, King of Prussia, Pennsylvania" (Woodward Clyde Consultants, August 1985). Near the completion of this investigation, a seep near the western edge of the site was first discovered. This was later defined by EPA as the fifth Off-Site Operable Unit.

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In November, 1985, SRW Associates submitted a report on an investigation conducted along the western edge of the property designed to further determine the extent of soil contamination in this area. The investigation included installing soil borings, collecting subsurface soil samples, and conducting a magnetometer survey. Results of this investigation indicated that no additional excavation would be required in this area. The results of the analysis of the soil samples collected during this investigation and a map of the soil boring locations are given in Appendix C.

#### 1.2.5 Off-Site Operable Units RI/FS

In the fall of 1985, CIBA-GEIGY Corporation agreed to conduct the further investigation of the Off-Site Area, the need for which was described in the 9 January 1985 ROD. EPA subdivided the Off-Site Area into five sub-areas or "Operable Units". Although the EPA terminology, Operable Unit, is used throughout this report, it does not imply that each Operable Unit is independent of the other units on the On-Site Area with regards to overall potential risk or remediation of the site. The Off-Site Operable Units include the following (Figure 1-2):

- Deep aquifer (Operable Unit 1)
- Hillside area (Operable Unit 2)
- Railroad area (Operable Unit 3)

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- Floodplain/wetlands (Operable Unit 4)
- Seep area (Operable Unit 5)

On May 27, 1986, an Administrative Consent Order (ACO) was signed for the Off-Site Operable Unit RI/FS. Prior to signing the ACO, EPA granted CIBA-GEIGY and ERM permission to initiate certain tasks of the Off-Site Operable Units RI/FS. This preliminary work included installing bedrock monitoring wells, conducting pumping tests, and collecting ground water samples. Monitoring well installation started in late November, 1985. The well installation, pumping tests, and preliminary sampling were completed by early April, 1986, after submittal of the final version of the work plan for the Off-Site Operable Units RI which was to be attached to the ACO. On 14 July 1986, at EPA's request pursuant to the provisions to the ACO, an addendum to the Off-Site Operable Units RI/FS Work Plan was submitted. This addendum outlined additional tasks regarding the Deep Aquifer Operable Unit. On 24 March 1987, a second addendum to the work plan was submitted to EPA. This addendum included a detailed investigation of the Schuylkill River and the installation of wells on the north side of the river.

This Off-Site Operable Unit RI report includes the results on all of the tasks originally described in the work plan attached to the ACO and in the first and second addendum to the work plan, except for the wells on the north side of the river. The results of the work on the north side of the river will be submitted to EPA upon its completion. This report also includes responses to

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all appropriate comments on the draft Off-Site Operable Unit RI submitted to EPA on 8 December 1986, along with the results of additional work requested by EPA at that time.

### 1.3 Objectives and Scope of Work

The objectives of the Off-Site Operable Unit RI/FS at the Tyson's Site are as follows:

- To determine the extent, severity, and risk to public health and the environment of any contamination in the five Off-Site Operable Units
- To delineate more fully potential contaminant migration pathways associated with the five Off-Site Operable Units
- To determine the extent of any remedial measures necessary to mitigate the potential threat from any contaminants which have migrated from the former lagoon area
- To identify a list of potential remedial actions for each of the Operable Units and evaluate the appropriateness and applicability of these control actions
- To recommend the most appropriate remedial action alternatives to mitigate the potential threats from

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those contaminants which may have migrated from the former lagoon area

During the FS, various approaches to remediation will be evaluated as per the most recent guidance under the Superfund Amendments and Reauthorization Act (SARA) and one or more measures will be selected and recommended consistent with a favorable cost/effect ratio.

The Off-Site Operable Units RI/FS for the Tyson's Site has been divided into three phases and twenty-three tasks. The phases and tasks are as follows:

**Phase I. Initial Remedial Investigation Activities**

- Task 1 - RI/FS Work Plan Preparation
- Task 2 - Site Reconnaissance
- Task 3 - Collection and Evaluation of Existing Data
- Task 4 - Development of a Site-Specific Health and Safety Plan
- Task 5 - Development of a Site-Specific Quality Assurance Plan
- Task 6 - Development of a Site-Specific Sampling Plan
- Task 7 - Mobilization of Field Equipment
- Task 8 - Procurement of Subcontractors
- Task 9 - Performance of Community Relations Support Functions
- Task 10 - Procurement of Permits, Rights of Entry, and Other Authorizations

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## **Phase II. Site Remedial Investigation Activities**

- Task 11 - Deep Aquifer Study (Operable Unit 1)
- Task 12 - Investigation of the Hillside Area (Operable Unit 2)
- Task 13 - Investigation of the Railroad Area (Operable Unit 3)
- Task 14 - Investigation of the Floodplain/Wetland Area (Operable Unit 4)
- Task 15 - Investigation of the Seep Area (Operable Unit 5)
- Task 16 - Performance of Data Reduction and Evaluation
- Task 17 - Selection of Remedial Action Objectives and Evaluation Criteria
- Task 18 - Identification of Potential Remedial Measures
- Task 19 - Preparation of Draft RI Report and Endangerment Assessment

## **Phase III. Feasibility Study**

- Task 20 - Preparation of Work Plan for Field and Laboratory Treatability Studies
- Task 21 - Performance of Laboratory and Field Treatability Studies
- Task 22 - Evaluation of Remedial Alternatives and Preparation of Draft FS Report
- Task 23 - Preparation of Final FS Report

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This document constitutes the RI report. It presents in text, figures, tables, and appendices the information obtained during the conduct of Phases I and II of this RI. The details of the investigation and a discussion of results and conclusions are given in Volume I of this Report. Volumes II, III, and IV include the appendices to Volume I. Volume V is the Endangerment Assessment for the Off-Site Operable Units. Table 1-1 lists the tasks presented above and their respective locations within this report and previous EPA-approved documents prepared by ERM.

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TABLE 1-1  
OFF-SITE OPERABLE UNITS RI LOCATOR

<u>Phase I</u>	<u>Task Description</u>	<u>Task Results</u>
Task 1 - Work Plan	----	Work Plan
Task 2 - Site Recon- naissance	Work Plan Page 2-1	*
Task 3 - Collection of Existing Data	Work Plan Page 2-2	*
Task 4 - Health & Safety Plan	Work Plan Page 2-2	Work Plan Appendix A
Task 5 - QA Plan	Work Plan Page 2-3	Work Plan Appendix B
Task 6 - Sampling Plan	Work Plan Page 2-3	Work Plan & Addendum
Task 7 - Mobilization of Field Equipment	Work Plan Page 2-3	NA
Task 8 - Procurement of Subcontractors	Work Plan Page 2-4	NA
Task 9 - Community Relations	Work Plan Page 2-4	NA
Task 10- Procurement of Permits, Rights of entry, & other author- izations	Work Plan Page 2-4	NA

\* These tasks not reported in this RI Report; information used during preparation of Work Plan.

NA = not applicable to a Potentially Responsible Party funded investigation

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TABLE 1-1 (cont'd)  
OFF-SITE OPERABLE UNITS RI LOCATOR

<u>Phase II</u>	<u>Task Description</u>	<u>Task Results</u>
Task 11- Deep Aquifer Study	Work Plan Page 2-6 & Addendum Page 2-1	RI Report Section 4
Task 12- Investigation of the Hillside Area	Work Plan Page 2-14	RI Report Section 4
Task 13- Investigation of the Railroad Area	Work Plan Page 2-16 & Addendum, Page 2-12	RI Report Section 4
Task 14- Investigation of the Floodplain/Wetlands Area	Work Plan Page 2-18	RI Report Section 4
Task 15- Investigation of the Seep Area	Work Plan Page 2-33	RI Report Section 4
Task 16- Performance of Data Reduction & Evaluation	Work Plan Page 2-25	RI Report Section 5
Task 17- Selection of Remedial Action Objectives and Evaluation Criteria	Work Plan Page 2-25	RI Report Section 7
Task 18- Identification of Potential Remedial Measures	Work Plan Page 2-25	FS Report (under preparation)

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TABLE 1-1 (cont'd)  
OFF-SITE OPERABLE UNITS RI LOCATOR

<u>Phase II</u>	<u>Task Description</u>	<u>Task Results</u>
Task 19-	Preparation of Draft RI Report and Endanger- ment Assessment	Work Plan Page 2-26
		Separate Documents

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## SECTION 2

### PHYSICAL AND ENVIRONMENTAL SETTING

#### 2.1 Regional Geology

The Tyson's Site is located in southeastern Pennsylvania and is within the Triassic Lowlands Physiographic Province just north of the Uplands section of the Piedmont Physiographic Province. The underlying bedrock strata of the Triassic Lowlands Physiographic Province are composed of shales, sandstones, and arkosic sandstones derived from the erosion of highlands in adjoining regions. These sediments were deposited in a downfaulting basin in the form of ancient alluvial deposits. The topography of this area is characterized by low ridges underlain by more resistant strata which often trend northeast to southwest along strike. Total relief in this region is generally less than 300 feet.

Unless otherwise cited, the following material is credited to Rima et. al. (1962). Bedrock underlying the site is part of the Newark Group of Triassic age sedimentary rocks, with some interbedded and intruded igneous rocks. In southeastern Pennsylvania, the Newark Group, in order of oldest to youngest, includes the Stockton, Lockatong, and Brunswick Formations. A generalized map of the Montgomery County regional geology is shown in Figure 2-1. Table 2-1 is a generalized stratigraphic column.

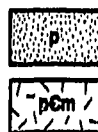
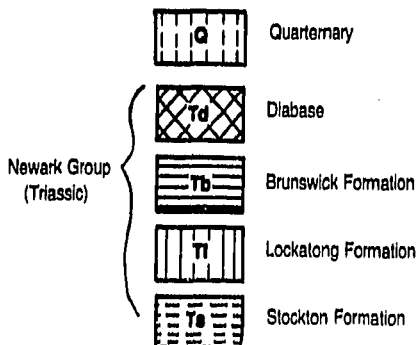
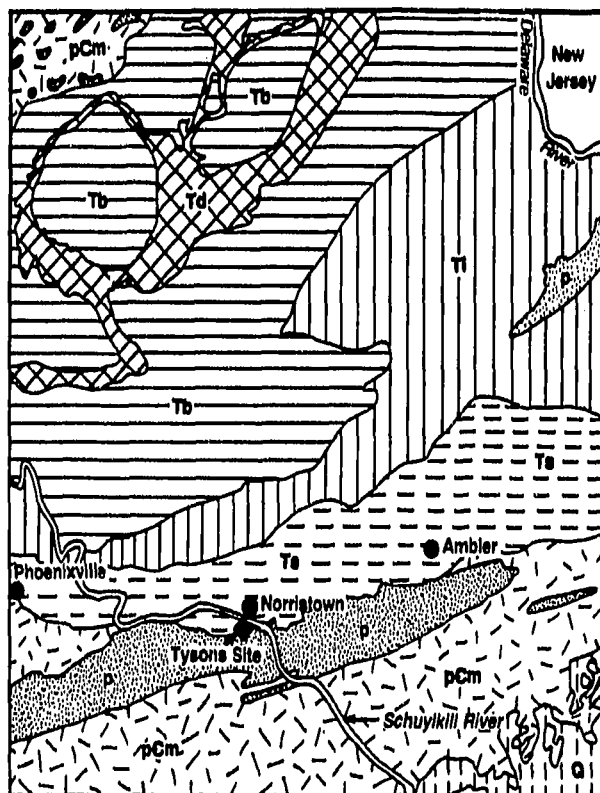
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**Figure 2-1**  
**Regional Geology**

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Paleozoic - Metamorphosed Carbonates and Sandstones  
 Precambrian - Schist, Gneiss and Serpentine

0 3 6  
Scale in Miles



Source: Newport, T.G., 1971



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Table 2-1

Geologic Sections for Montgomery County, Pennsylvania (Newport, 1973).

MESOZOIC	FORMATION	DESCRIPTION
Triassic		
	Brunswick Formation	Shale, mudstone, sandstone, and conglomerate beds; reddish brown.
Newark Group	Lockatong Formation	Argillite, mudstone, and shale; dark gray to black, thick-bedded.
	Stockton Formation	Shale and siltstone in upper member; sandstone, fine- to coarse-grained arkosic, middle member; conglomerate lower member.
PALEOZOIC		
Ordovician		
	Conestoga Formation	Limestone, impure, thin bedded upper part; middle dark gray phyllite, lower limestone granular thick-bedded dark grey.
	Elbrook Formation	Limestone, fine-grained, light gray to cream colored, thin-bedded.
	Ledger Formation	Dolomite, granular, gray to bluish gray.
	Harpers Formation	Phyllite, fine-grained, greenish-gray, some beds of quartzite and schist.
	Chickies Quartzite	Quartzite, vitreous, light-colored thick-bedded, conglomerate at base.
CENOZOIC		
	Precambrian (?)	
	Wissahickon	Schist, albite chlorite, and oligoclase mica, includes hornblende, gneiss, and phyllite.
	Precambrian	
	Granite gneiss	Composed chiefly of quartz, feldspar, biotite and hornblende.
	Hornblende gneiss	Composed of quartz, feldspar, and hornblende.
	Serpentine	Soft, fine-grained, green.

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The site is completely underlain by the Stockton Formation. Sediments of the Stockton Formation were derived from the erosion of metamorphic and igneous mountains to the south. The fluvial transport and subsequent deposition of these eroded sediments was into a large basin in a form of coalescing alluvial fans. During periods of major flooding, the rapid deposition of slightly weathered rocks from the mountains resulted in beds of coarse-grained arkosic sandstones and conglomerates. Finer grained sediments, such as shales and siltstones, were deposited during the periods of minor flooding. These processes resulted in the alternating sandstones and shales which characterize the Stockton Formation. Significant lateral variation is also seen in the lithologies of this formation. This is a result of finer sediment being deposited in stream channels, while large clasts deposited during flood events occupy areas between channels. The Stockton Formation has been divided into three members: the Lower, Middle, and Upper, based on the relative percentages of conglomerates, sandstones and shales. These members are described as follows:

- Lower Member - coarse-grained arkosic sandstones and conglomerates,
- Middle Member - fine-medium well-sorted arkosic sandstones,
- Upper Member - shales and siltstones.

The Stockton Formation has its greatest thickness of more than 6,000 feet east of the site near the Montgomery/Bucks County line.

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The Stockton Formation gradually thins to the west and has a thickness of 4,000 feet at Norristown and 2,300 feet at Phoenixville.

The beds in the Newark Basin, including the Stockton Formation in southeastern Pennsylvania form a simple monocline. Beds of the Stockton Formation in the vicinity of the site generally strike northeast-southwest and dip an average of 12 degrees to the north-northwest. This dip was calculated based on 73 measurements made throughout the Stockton Formation in southeastern Pennsylvania. A range of dips between 5 and 25 degrees was measured and 50 percent of the dips measured were between 10 and 14 degrees.

Major faulting is not extensive in the Stockton Formation of southeastern Pennsylvania. Minor faults with displacements measuring less than 10 feet are common, and can be observed in many outcrops of the Stockton Formation. The only major faulting located within the vicinity of the site is in excess of 1.5 miles to the west and consists of an intricate series of faults with displacements as great as 0.5 miles.

Vertical jointing is common in the Stockton Formation. The most common vertical joint set occurs perpendicular to the strike of bedding. Vertical joint sets parallel to strike and trending northwestward at a 50 degree angle to strike are also common in the Stockton Formation.

The Lower Member of the Stockton Formation directly underlies the site and consists of medium-to-coarse arkosic sandstones (>25%

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feldspars) and arkosic conglomerates with some interbedded red shales and siltstones. Strata of this lowermost member have colors which vary widely but include light grey, pale orange, reddish brown, and various shades of green and grey. Micas, predominantly in the form of biotite, are common throughout units in the Lower Member of the Stockton.

The Lower Member of the Stockton Formation has a maximum thickness of 2,700 feet, east of Ambler, Pennsylvania,  $\pm 7.5$  miles east of the site. It thins to the west, with a thickness of 500 feet at Phoenixville, 8.75 miles west of the site. The Lower Member is estimated to be at least 1,000 feet thick in the vicinity of the site, unless faulting not expressed on the surface has occurred underneath the site to reduce this thickness.

## 2.2 Regional Hydrogeology

Ground water in Montgomery County exists under both confined (artesian) and unconfined (water table) conditions. Wells have wide ranging yields, from 1 gallon per minute (gpm) to more than 1500 gpm (Newport, 1973). Total ground water use in Montgomery County is estimated at 53.3 million gallons per day (mgd) (Gast, 1986), which is 50 percent of the total water usage in the county.

Ground water supplies in Montgomery County are obtained from bedrock formations. This is caused by the thin (commonly less than 20 feet) and discontinuous nature of overburden deposits

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which are unable to supply usable quantities of ground water. Although ground water supplies can be obtained from Precambrian and Paleozoic Formations along with the Triassic, Lockatong and Brunswick Formations, the following discussion of regional hydrogeology will be limited to the Stockton Formation which underlies the site area at reported thicknesses of greater than 1000 feet.

The lithologic variations between the members of the Stockton Formation have resulted in differing hydrogeologic characteristics of the members. In the Lower and Middle Member of the Stockton Formation, both the primary and secondary porosity features are important in defining the movement of ground water. Both the Middle and Lower Members of the Stockton Formation are considered to be reliable water-bearing units as a result of fracturing and the lack of cementing.

A number of pump tests have been completed in the Stockton Formation and are described by Rima, et. al. (1962). In a fractured bedrock aquifer having variable lithologies and hydrologic properties, pump test data do not match type curves, except during the initial stages of pumping (Rima et. al., 1962). Therefore, hydrogeologic calculations of transmissivity and storage coefficients cannot be considered reliable indicators of the aquifer over a large area. However, for those pump tests conducted in the Stockton Formation, calculated transmissivity values ranged from 13,000 to 18,000 gallons per day per foot and storage coefficients between  $2 \times 10^{-4}$  and  $2 \times 10^{-5}$ .

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Ground water quality in the Stockton Formation in Montgomery County is described by Rima, et. al. (1962) based on the chemical analyses of samples from seventy wells. The dominant dissolved constituents identified are: calcium, magnesium, sodium, potassium, iron, bicarbonate, carbonate, sulfate, chloride, fluoride, and nitrate. By far, calcium and magnesium were the most common cations and accounted for over 50 percent of the equivalents per million. The major anions in waters of the Stockton Formation with a percentage of equivalents equal to or exceeding 50 percent were bicarbonate and carbonate. It should be noted that the bicarbonate anion was dominant with the carbonate ion being present in small amounts at just seven wells. The median iron content was 0.15 parts per million (ppm) and can be considered a trace constituent of the ground water sampled. Of interest was the occurrence of high dissolved solids content in wells located in urban areas when compared to suburban areas. This is thought to be indicative of ground water contamination caused by urbanization.

### 2.3 Demography

Upper Merion Township has a population of approximately 26,000. This represents an increase of 308 percent since 1950, with an average annual increase of 10 percent since 1970. The population of the Township from 1940 to 1980 is presented below (Supervisors of Upper Merion Township, 1985):

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Census Year	Population
1940	6,143
1950	6,404
1960	17,096
1970	23,743
1980	26,138

Much of the growth in this Township has been attributed to expansion of commercial enterprises from the city of Philadelphia, as well as movement of people from Philadelphia or other large east coast cities to this small (16.8 sq. miles) community.

The population of the Township is comprised primarily of young, middle-income families working in the Philadelphia or King of Prussia areas. Only 19 percent of the Township is age 55 or older.

In 1980, the work force within Upper Merion consisted of 33,000 people; it is estimated that by the year 2000, 47,294 people will be employed within township boundaries. Employment is primarily at the professional/managerial level, in the commercial or office sectors.

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#### 2.4 Land Use

There are approximately 10,500 acres of land in Upper Merion Township. Of this, 31 percent (3,254 acres) is devoted to residential use and 22 percent is under either commercial/industrial or institutional/recreational development. Commercial/industrial land uses include shopping centers, office complexes, light industry, and quarry operations. Institutional/recreational development includes churches, schools, cemeteries, municipal facilities, parks, and open space. Eighteen percent of the total land area of the Township is considered open space.

The site is located in the Belmont Planning Area of the Township and is presently inactive; however, a subdivision with 58 single family homes has recently been constructed to the west and adjacent to the site. The majority of land within the 840 acre Belmont area is similarly devoted to single family, detached housing units at a density of 2.87 dwellings per acre. The development of vacant parcels in this planning area is limited due to terrain features (steep slopes) and flooding potential.

Other residential and commercial areas are located within close proximity of the site. These include Norristown, Pennsylvania, located across the Schuylkill River approximately one-half mile northeast of the site, and Bridgeport, Pennsylvania, one mile east of the site on the Schuylkill River.

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## 2.5 Natural Resources

The area around the Tyson's Site supports a diverse flora and fauna. Vegetation observations made during a site reconnaissance are presented in Section 4.6.1.1 and Table 4-14. Vegetation types range from upland species along the railroad and higher elevations to floodplain/wetland assemblages in the lower elevations where the plants range from obligate wetland species to facultative upland species.

During the reconnaissance survey twenty-six (26) species of birds were also observed (see Table 4-15). During the course of additional field work several waterfowl were observed in the pond associated with the wetland area. A pair of Canada geese and Mallard ducks were observed nesting in the pond/adjacent wetland. Ring-necked pheasants (both juvenile and adult) were commonly sighted. Pickerel frogs and green frogs were observed in the pond/wetland and in ponded areas on most drainage ditches as well as along the shore of the Schuylkill River. Snapping turtles were captured for tissue analysis from the Schuylkill River.

Signs or actual sightings of mammals included opossum, cottontail rabbit, gray squirrel, skunk, racoon, muskrat, and white-tailed deer.

Harvest of terrestrial resources by hunting is restricted by township ordinance forbidding the discharge of firearms. Mr. William Wasserman (Pennsylvania Game Commission - Game Protector) in a telephone conversation on April 24, 1987, indicated some illegal hunting still takes place despite the

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restrictions. No survey or estimate of hunter success was available. Mr. Wasserman suggested that the trapping of muskrats for fur is possible in the area. He had no idea if the meat was consumed.

Based on Mr. Wasserman's knowledge of the area, habitat quality, and reduced hunting pressure, Mr. Wasserman would characterize the wildlife resources in the area as good.

The Schuylkill River supports a number of game fish in the site vicinity. Telephone conversation with Mr. Mike Kaufmann (Pennsylvania Fish Commission - Fisheries Manager - Quakertown) indicated that the following game fish are actively sought in the area: muskellunge, large-mouth bass, channel catfish, bullhead catfish, rock bass, and bluegills. In addition, carp are harvested for consumption as well as Corbicula clams by certain groups.

Due to the presence of two public boat launch areas (Norristown and Valley Forge Park) the area receives considerable fishing pressure from boaters as well as from shore fishermen. The large mouth bass population is good enough to support bass tournaments. Mr. Kaufmann was unaware of any creel census or fishing effort studies in the area, but characterized fishing pressure as high.

Historically, the Schuylkill River supported anadromous fisheries. The construction of dams below the site stopped any anadromous fish from migrating. Future efforts to breach the dams or equip them with fish ladders could restore the anadromous fish populations. In anticipation of the potential return of

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unrestricted access to and from saline waters, the Pennsylvania Fish Commission had, in 1986, stocked fingerling shad at several locations in the river upstream of the site for home stream imprinting. Schuylkill imprinted juveniles are not expected to return from the sea for 4-6 years. According to Mr. Kaufmann, the permitting process and local opposition may delay the fish ladders planned for the Flatrock Dam and the planned breaching of the Plymouth Dam. The Norristown Dam may be eventually equipped with fish ladders as part of the development as a hydropower facility.

No threatened or endangered species of birds and mammals or fishes, amphibians and reptiles are known to occur on or in the vicinity of the site. This determination is based on letters of inquiry to Mr. Jacob Sitlinger (Pennsylvania Game Commission - Birds and Mammals) and Mr. Clark Shiffer (Pennsylvania Fish Commission - Fish, Amphibians and Reptiles).

Information provided by the Pennsylvania National Diversity Inventory (Ms. Kathleen Regan) indicated that no threatened plants are known to occur on or in the vicinity of the site.

The pool created by the Norristown Dam along with two public boat launch areas has resulted in heavy boating usage both for fishing and recreation. The deeper areas are popular for water skiing and pleasure cruising. Children have been observed wading, generally in the boat launch areas.

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## 2.6 Climatology

The climate of Montgomery County is characterized by warm, humid summers, moderately cold winters, and ample rainfall. The average annual temperature ranges from 32°F in January to 77°F in July (Smith and Soil Survey Staff, 1967). Average minimum and maximum temperatures during the period of 1951 to 1980, as recorded at the Phoenixville Station (the closest temperature recording NOAA station, located approximately 15 miles northwest of the site), are presented in Table 2-2.

The average annual precipitation for Montgomery County, including both rainfall and the water equivalent of melting snow, is 42 inches. Precipitation normals during the period of 1951-1980, as recorded at the Norristown Station (the closest precipitation recording NOAA station, located approximately one-half mile northeast of the site), are presented in Table 2-2.

Variations in temperature and precipitation across the county do occur. For example, Phoenixville had an average annual precipitation of 43.55 inches between 1951 and 1980, whereas Norristown averaged 44.45 inches during the same period. These variations, similar to those which occur in temperature, are attributed to differences in local relief. The range in elevation in Montgomery County is 100-400 feet; minimum temperature readings tend to be lower in valleys, whereas precipitation is somewhat lower in areas of higher elevation. Weather patterns are also occasionally influenced by the Atlantic Ocean, which is approximately 75 miles southeast of the site (Smith and Soil Survey Staff, 1967).

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TABLE 2-2

**Historical Temperature and Precipitation**  
**Temperature (°F) as recorded at Phoenixville, PA**  
**(1951-1980)**

<u>Month</u>	<u>Average Daily Maximum</u>	<u>Average Daily Minimum</u>	<u>Mean</u>
January	40.0	20.1	30.1
February	42.9	21.6	32.2
March	52.5	30.1	41.3
April	65.1	39.1	52.1
May	75.3	48.9	62.1
June	83.2	57.8	70.5
July	87.4	62.3	74.9
August	85.8	60.6	73.2
September	78.9	53.9	66.5
October	67.7	42.3	55.0
November	55.4	33.7	44.6
December	43.9	24.7	34.3
Annual	64.8	41.3	53.1

Source: NOAA, 1980

**Average precipitation (inches) as recorded at Norristown, PA**  
**(1951-1980)**

<u>Month</u>	<u>Precipitation</u>
January	3.29
February	2.95
March	4.07
April	3.63
May	3.64
June	3.59
July	4.18
August	4.46
September	4.10
October	3.18
November	3.65
December	3.71
Annual	44.45

Source: NOAA, 1980

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## 2.7 Flood Potential

Flood elevations (Flood Insurance Study, Township of Upper Merion) for the Schuylkill River, the major waterway in the vicinity of the site, as recorded approximately one mile upstream from the site at the Norristown Dam, are:

<u>Flood Frequency</u>	<u>Elevation (feet above MSL)</u>
10 year	70.5
50 year	77
100 year	80
500 year	87

The site, located approximately 110 feet above mean sea level (MSL) is not located within the flood plain. The railroad (80 feet above MSL) and other areas downgradient from the site are located within the 100 year floodplain.

The average discharge of the Schuylkill River, as recorded at Pottstown, Pennsylvania (the nearest U.S. Geological Survey gauging station, approximately twenty-five miles upstream from the site) for a 57 year period (1926-1983) was 1,890 cubic feet per second (cfs). The maximum and minimum discharges recorded at Pottstown during this period were 95,900 cfs and 175 cfs, respectively (White et. al., 1984).

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## 2.8 Site Drainage

The site is located in an abandoned sandstone quarry, approximately 550 feet south of the Schuylkill River. The sandstone quarry was excavated into the side of a small ridge. This old excavation takes the form of a bench, thirty to sixty feet above the Schuylkill River. Directly below the quarry is a railroad switching yard and the Schuylkill River floodplain.

The areas formerly occupied by the lagoons are not affected by natural drainage channels. Minor regrading of the former lagoon areas by the EPA enhanced surface drainage and prevented water from ponding in the former lagoon area, minimizing infiltration into the soils. The leachate collection system installed by EPA collects much of the surface water drainage originating from the site (Plate 1). This work was completed as part of the immediate removal actions in March, 1983.

Two unnamed tributaries to the Schuylkill River are located to the east and west of the former lagoon areas (Figure 2-2). The eastern tributary occupies a large north-south trending ravine which originates more than 1000 feet south of the site. The upper reaches of this stream are undeveloped and heavily wooded. The part of this tributary which crosses the site was re-channelized as part of the immediate removal actions to diminish the possibility that contaminants on site would be released into the stream. The stream, upon reaching the fence which bounds the On-Site area, flows through several culverts and then passes beneath the railroad tracks into the floodplain where

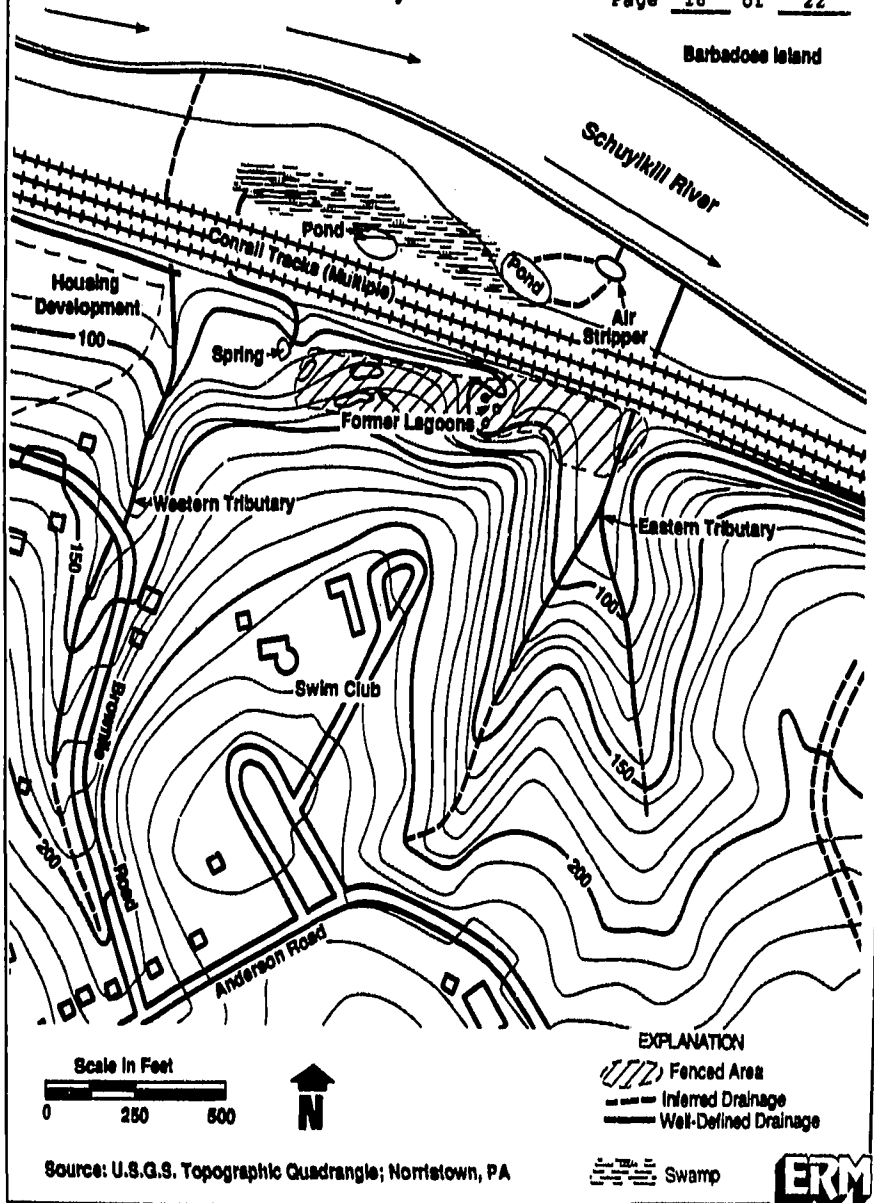
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**Figure 2-2  
Drainage Features  
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it discharges into the Schuylkill River. This tributary is characterized by minimal discharges which are directly related to variations in seasonal precipitation.

Another north-south trending tributary flows through a deep ravine and forms the western boundary of the site. This tributary receives drainage from the homes in the area and flows parallel to Brownlie Road for approximately 1500 feet. When Brownlie Road turns westward, the tributary flows beneath it, northward past the former lagoon area, beneath the railroad tracks and onto the floodplain. Upon reaching the floodplain, the stream enters a series of swampy depressions and small ponds, eventually discharging to the Schuylkill River or infiltrating the soils in the floodplain. This tributary has been characterized by variable discharges of relatively low volume. Seasonal variations and storm-related events directly affect the tributary's base flow discharge.

A spring originates from a round concrete spring box just below the westernmost fenced area of the site. The measured discharge at this spring has varied from 2.5 gpm to 15 gpm. The discharge rate of this spring appears to be directly related to precipitation in the area. The spring flows north for less than 100 feet where a drainage ditch running along side the railroad tracks diverts flow beneath the railroad tracks onto the floodplain into a swampy area.

The floodplain north of the site contains two seasonal ponds and several swampy areas which are adjacent to the railroad tracks. During prolonged dry periods, the ponds and swamps do not contain

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standing water and the flow from the western tributary infiltrates the floodplain soils. Under normal conditions, the water entering these areas discharges into the Schuylkill River through numerous small channels.

The air stripper installed by the EPA as part of emergency remedial measures discharge water onto the floodplain just west of the eastern tributary. The discharge then follows a small channel through the floodplain to the river.

## 2.9 Other Significant Features

The general vicinity of the RI study area has many features which are indirectly related to the actual investigation. However, these features are meaningful to the total understanding of site conditions. The Conrail railroad tracks, which divide the floodplain from the ridge on which the former lagoon area is located, are likely the oldest man-made features in the area. Their presence is significant because the track construction and right-of-way made the area accessible. They also can be a significant source of contamination due to the materials used for the railroad construction and the materials transported by the railroad. The tracks parallel the Schuylkill River and are built on the remnant floodplain of the Schuylkill River.

An 8-inch natural gas pipeline (Plate 1) owned by Transcontinental Gas Pipe Line Corporation was reportedly installed while the Tyson's Site was active. The pipeline right-of-ways are well marked and maintained.

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the property, but not in use. The source of water for the club during operation is unknown.

During the early investigations at the site, a leachate collection system was installed. The design of the system required re-directing natural run-off to a perforated pipe-sump collection system in the ditch south of the railroad tracks and to an air stripping water treatment plant. Following treatment, water is discharged to an unnamed tributary that empties into the Schuylkill River. These features are shown on Plate 1.

Concurrent with the RI field work conducted by ERM, AT&T subcontractors installed a fiber optics cable along the railroad track right-of-way. The installation of the cable required trenching to a depth of approximately thirty inches (Plate 1).

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**3**

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## SECTION 3

### FIELD INVESTIGATION

#### 3.1 Preliminary Work

As discussed in Section 1, several tasks of the initial Work Plan were begun before signing of the ACO. The following preliminary results were obtained from this initial work and dictated an addition to the initial Work Plan:

- Elevated levels of ground water contamination were detected in all of the downgradient and lateral well nests (Well Nests 2 through 8);
- Ground water contamination was found to occur in two phases: a dissolved phase and a dense non-aqueous phase liquid (DNAPL); and
- Measurable thicknesses of DNAPL were found in the bottom of Wells 2-S, 3-S, 3-I, 5-S, 6-S, and 8-I.

Based upon these results the first Addendum to the Work Plan was prepared and approved by EPA. The first Addendum included the following additional tasks:

- A residential and commercial well inventory with emphasis on wells on the north side of the Schuylkill River

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- Collection of river sediment and bottom water samples from the Schuylkill River
- A long-term pump test
- DNAPL recovery tests
- Installation of additional Wells Nests 9 through 12
- Installation of additional soil borings along the railroad tracks

As the first addendum additional tasks were being conducted, it became evident that several other tasks would also be necessary, including: wells on the north side of the river, piezometers in the river and additional river water sampling, and additional bioassays. These tasks are described in the second addendum and in the following section except for the wells on the north side of the river which as of the date of this report had not been sampled.

### 3.2 Deep Aquifer (Operable Unit 1)

#### 3.2.1 Monitoring Well Installations

Thirty-three bedrock monitoring wells were installed at 12 locations (Figure 3-1) between November 1985 and September 1986, using the Air Rotary/Hammer drilling methods. Well nests of two, three, or four wells were installed at 11 locations. A single background well was installed at Location 1. Excluding Well Nests 2, 10, and 12, each monitoring well nest consists of a shallow (S), intermediate (I), and deep (D) well completion. The range of completion depths for these wells is 44-84, 95-163, and

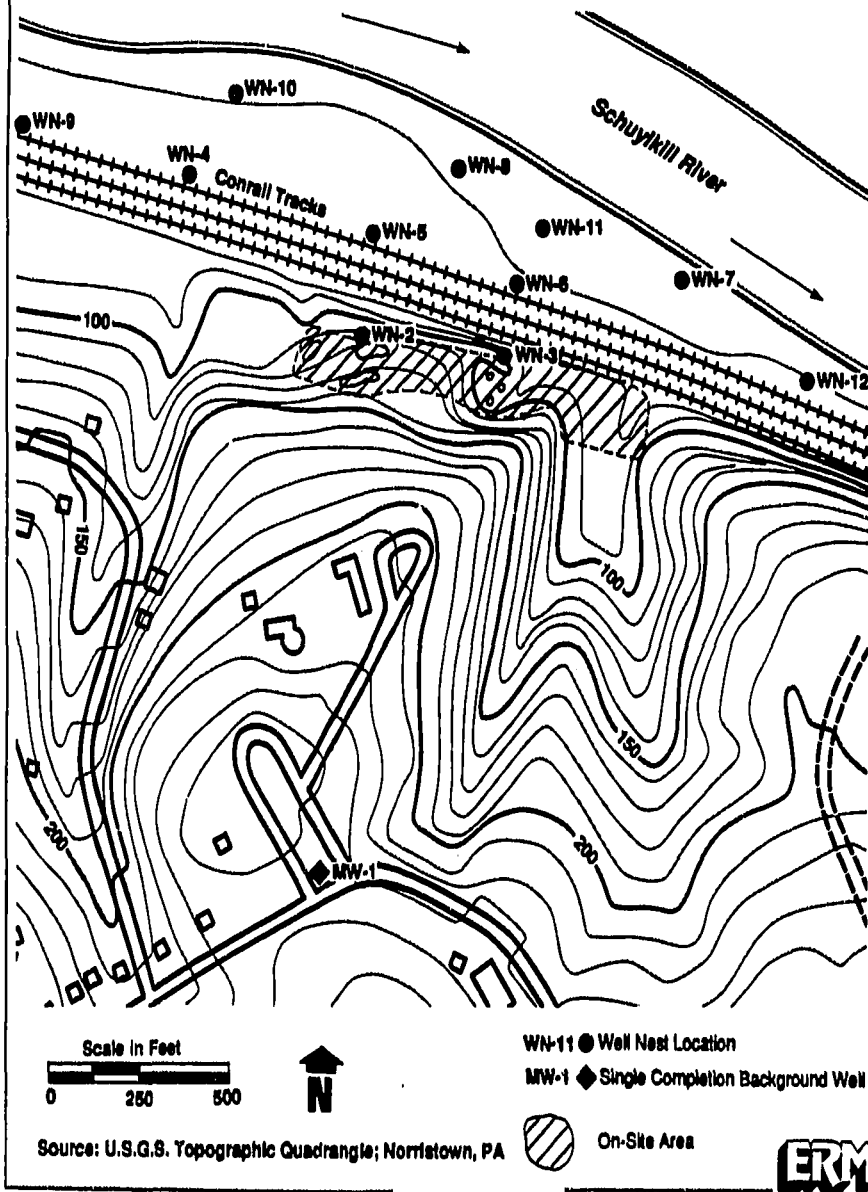
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**Figure 3-1  
Tyson's Site  
Well Nest Locations**

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173-222 feet for shallow, intermediate, and deep wells, respectively. Two wells were installed at Well Nests 2 and 12, and an extra deep (XD) well of 307 feet total depth was installed at Well Nest 10. The background well was installed to a total depth of 100 feet. Well specifications are presented in Table 3-1. All of the wells were drilled and installed by Hawkins Drilling Company of Somerville, New Jersey under the constant observation of an ERM hydrogeologist.

Well nest locations were chosen to define the lateral and downgradient migration of any contaminants from the site. A fracture trace analysis was conducted prior to well installation to assist in positioning wells so that the preferential flow path might be intercepted. The following rationale was used for determining each well nest location:

- Well location 1: A single upgradient well to assess background ground water quality conditions
- Well locations 2 and 3: Immediately downgradient of the lagoons and outside of the fenced area
- Well locations 4, 7, 9 and 12: Located to assess the lateral limits of the potential contaminant plume
- Well locations 5, 6, 8, 10 and 11: Located to determine the downgradient extent of the potential contaminant plume

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TABLE 3-1  
MONITORING WELL SPECIFICATIONS

Well No.	Total Depth (feet)	Open Interval* (feet)	Yield Estimate (gpm)
1	100	20.5-100	<1
2-S	51	29.5-51	1.5-2.5**
2-I	135	110-135	10 **
3-S	44	23-44	1 **
3-I	99	75-99	<1 **
3-D	175	123-175	<1
4-S	62	32-62	<1 **
4-I	110	84-110	<1
4-D	175	133-175	<1
5-S	60	30-60	9-10 **
5-I	122	90-122	<1 **
5-D	180	156-180	<1
6-S	50	30-50	1-1.5**
6-I	95	75-95	<1 **
6-D	173	115-173	<1
7-S	72	30-72	<1 **
7-I	163	143-163	1 **
7-D	214	189-214	<1
8-S	60	30-60	8.0 **
8-I	135	115-135	<1 **
8-D	183	153-183	<1
9-S	72	32-72	2.5
9-I	157	117-157	<1
9-D	223	188-223	<1
10-S	55	32-55	10-20
10-I	137	97-137	<1
10-D	222	183-222	<1
10-KD	307	268-307	2-3
11-S	84	44-84	<1
11-I	149	109-149	<1
11-D	220	180-220	<1
12-S	100	60-100	4
12-D	185	145-185	<1

NOTE: All values are in feet below ground surface.

\* Open Interval = nominal 6-inch I.D. open borehole

\*\* Based upon step tests; other yields were estimated during development.

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Prior to well installation, access improvements were necessary at some of the locations. These access improvements included:

- Temporary partial removal of the security fence around the former lagoon area for the wells at locations 2 and 3
- Construction of a stone pad at locations 3, 5, and 6 to support the drilling rig
- Removal of some trees and shrubs at most well nests to accommodate the drilling rig
- Construction of access roads for all well nests located on the floodplain
- Construction of a wooden bridge over a natural gas supply line in the floodplain so that the wells at locations 7, 8, 10, and 11 could be accessed
- Excavation of an access trench to allow overhead clearance for the drilling rig at locations 5, 6, and 12

Well locations 3, 4, 5, 7, and 11 were positioned along fracture traces which are discussed in greater detail in Section 4.1.4. The depth of each open interval was determined by the volume of water encountered during drilling. Given the low yielding nature of the formation in which the wells were completed, it was necessary to complete each well such that several water-bearing zones were penetrated. Well specifications required at least

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20 feet of separation between open intervals at each well nest. Figure 3-2 depicts a typical well nest construction schematic. Correlation of geologic units and an estimated regional dip of 12 degrees was used to calculate depth discrete water-bearing zones between well nests.

Wells were constructed by advancing a 14-inch diameter borehole, using the air rotary drilling method, through the upper unconsolidated material until bedrock was encountered. The 10-inch surface casing was installed through the unconsolidated material and seated into the upper 1 to 2 feet of bedrock to keep the 14-inch hole open and to prevent contaminants from migrating vertically. After installation of the 10-inch casing, a 10-inch borehole was advanced, using the air hammer drilling method, to the desired depth for casing installation. After steam-cleaning, the well casing (6-inch I.D. steel) was displacement grouted and then driven into place to ensure proper seating. All wells were completed by drilling a nominal 6-inch open borehole a minimum of 20 feet beyond the well casing. The design of the wells, such that the wells were double-cased and these casings were grouted in place will prevent vertical mass contamination.

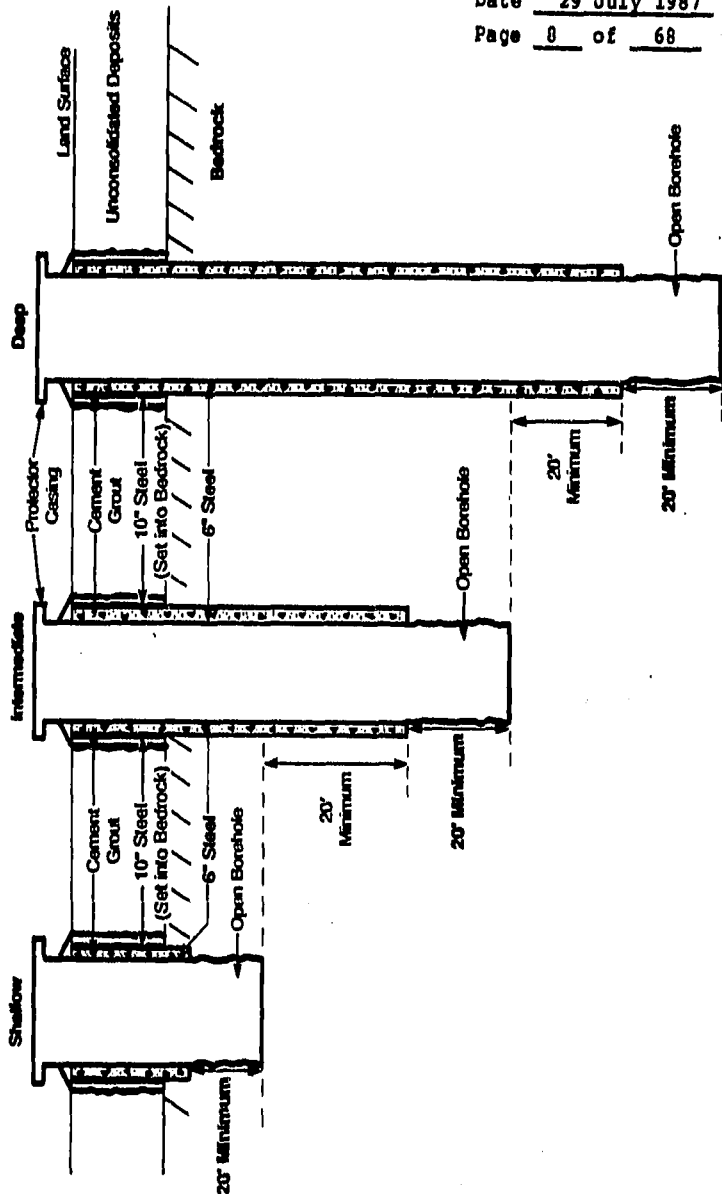
The actual interval of the open borehole was determined by the known geology. Open borehole advancement was terminated when it was determined that enough water-producing zones were penetrated to provide an adequate volume for sampling. The average open interval is 33 feet, excluding the 80 foot interval of the background well.

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**Figure 3-2**  
**Well Nest Construction Schematic**  
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Deviations from the above well construction are as follows:

- A single 6-inch casing was used in the construction of the background well, MW-1;
- Because artesian conditions were encountered during installation of Well 5-I and Well 5-D, the well casing was first driven into place, and then tremie-grouted to ensure a proper seal; and
- The cable tool drilling method was used to expedite the installation of the 10-inch I.D. casing at well locations 4, 5, and 7.

To determine the nature of DNAPL occurrence within the bedrock aquifer beneath the former lagoon area and provide a means of testing the effectiveness of remediation in this area on unsaturated bedrock underlying the former lagoon area, two shallow bedrock wells and a third boring into bedrock were completed within the eastern lagoon area. These wells and borings have been located on Plate 3.

At each location 6-inch I.D. hollow stem augers were advanced 1.0 to 1.5 feet into competent bedrock. Split spoon samples were collected at 5 and 10 foot intervals with five soil samples being collected at SB-1, and SB-3 for material description. Four inch I.D. black steel casing was seated and Type I portland cement grout was tremie-piped to the surface at SB-1 and SB-2. The grout was allowed to set overnight prior to bedrock coring and in addition, at SB-3, coring was completed within the augers.

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Thirty feet of NX coring was completed at each location. Immediately following field logging, the cores were placed into clear 4-inch I.D. PVC tubing and submerged in water to minimize the potential of volatilization of organic compounds. Upon completion of the cores at Wells SB-1 and SB-2 each well was reamed to a nominal 4-inch size. A 6-inch I.D. steel protective casing with locking cap was installed in each well. Boring SB-3 was tremie grouted to the top of bedrock. The remaining borehole was then backfilled with cuttings.

Upon completion, each well was developed by either air surging or pumping to remove turbidity and residual cuttings. In the air surging method, water derived from the formation was used for development of wells yielding adequate water. Potable water obtained from the PA American Water Co. in Norristown, Pennsylvania was added to wells in which recharge was slow. To more adequately develop very low yielding wells, a second method using down hole submersible pumps, air lifting and/or jet pumps was used at a later date. After a well was fully developed, approximately 3 feet of 6-inch I.D. steel riser pipe was added at the surface, and a protective locking well cap was installed. Wells were then surveyed for both horizontal and vertical control by James M. Stewart, Inc., Philadelphia, Pennsylvania, a licensed surveyor.

To reduce the possibility of creating surface soil contamination during well installation, a system was implemented to divert well cuttings and purge water from the borehole into a collection basin lined with plastic sheeting. All collected purge water was pumped into 5,000-gallon Delaware Container tanker trucks and treated at E.I. duPont de Nemours & Co. treatment facilities in

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Deepwater, New Jersey. Well cuttings were handled and taken by Chemical Waste Management, Inc. for disposal in Emelle, Alabama. After each well nest was completed, the collection basin was cleaned, scraped, and backfilled to the original surface elevation.

As part of a general decontamination procedure used at the site, the drill rig and all downhole tools were steam-cleaned prior to any drilling and at the end of the investigation. The rear portion of the rig and all downhole tools were also steam-cleaned between drilling of wells and various times during drilling of individual wells to prevent cross-contamination between wells and between intervals in wells. All decontamination activities took place on a decontamination pad. Wash water was collected and handled in the same manner as collected purge water.

### 3.2.2 Hydrogeologic Field Testing

The hydraulic properties of the underlying bedrock aquifer were investigated by measuring water levels and conducting aquifer testing which included plug tests, constant drawdown tests, and step-drawdown tests. Water level measurements were measured on a routine basis from March 1986 through July 1987. Aquifer testing was completed during the winter and spring of 1986 on Well Nests 2 through 8, and during the spring of 1987 on Well Nests 9 through 12 (including a re-test of Well 2-S).

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### Water Level Measurements

The acquisition of water level data from both bedrock and overburden wells has been an on-going task since the beginning of the investigation. This was particularly important considering the complex geology at the site and the slow recovery of the deepest bedrock wells. Measurements were undertaken in March of 1986, and continued until August 1986. Monthly water levels were obtained in September and October of 1986, but not during November. During December 1986, January 1987, and February 1987, incomplete sets of water level data were collected. To closely monitor bedrock wells, water levels were collected weekly, between 6 April and 1 May 1987, and bi-weekly from 1 May to 1 July.

Nine wells at the Tyson's site (5-S, 5-I, 5-D, 6-D, 8-I, 8-D, 10-XD, 11-I and 11-D) exhibit artesian water levels. In the past, water levels were obtained on these wells by affixing a clear PVC tube to the well or adding as much as 10 feet of additional steel stand pipe to the well, and allowing for visual equilibration of the water level to occur. Water levels were then measured as height above top of casing (TOC). On 6 April 1987, PVC tubing was affixed to the flowing wells, as shown in Figure 3-3, in order to allow the water level to equilibrate prior to measurement.

The apparatus consists of a 6-inch cast iron test plug, which seals the well. To the test plug is attached a 10-foot length of clear 1/2-inch I.D. PVC tubing with an in line PVC ball valve. This apparatus is supported by a wooden frame attached to the well by two 10-inch stainless steel band clamps.

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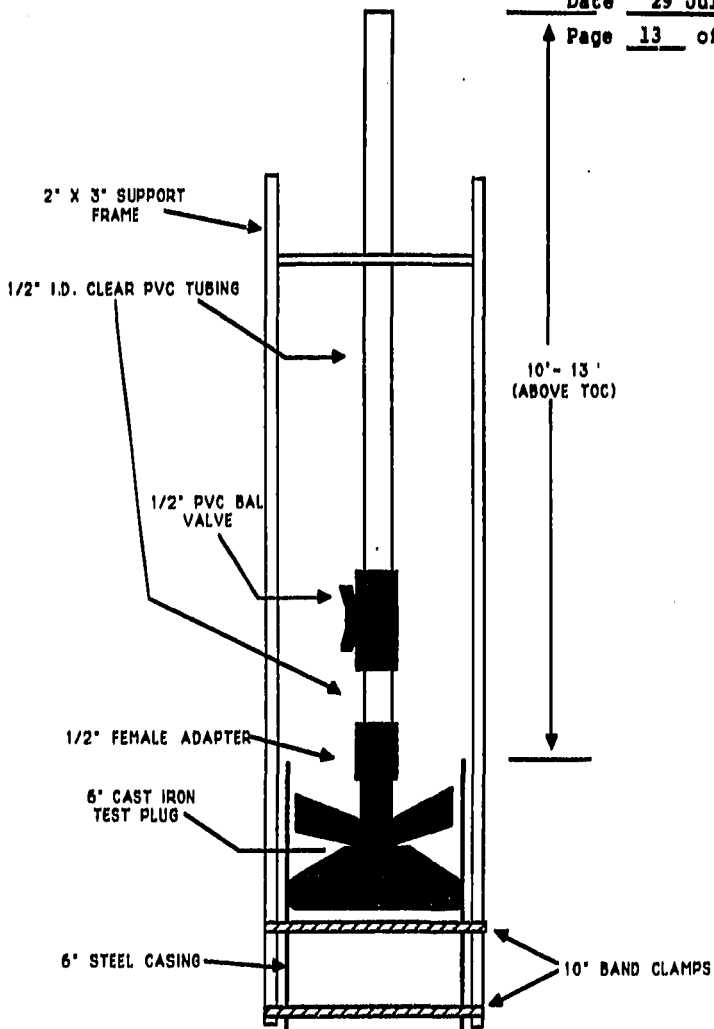
**Figure 3-3**  
**Apparatus Used to Measure Water Levels**  
**In Flowing Artesian Wells**  
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Upon completing the installation of this apparatus, all wells were closely monitored during the month of April 1987 to determine if equilibrated water levels were being measured. Weekly and subsequently bi-weekly measurements were taken from May through July 1987.

#### Slug Test

Slug tests were performed on wells 2-S, 2-I, 3-S, 3-I, 3-D, 6-S, 6-I, 9-S, 9-I, 9-D, 10-S, 10-I, 10-D, 11-S, 12-S, and 12-D to derive values for hydraulic conductivity (K) and aquifer transmissivity (T).

A static water level reading was taken in the well prior to testing. A 4-inch I.D. submersible pump fitted with a check valve was installed in each well to be tested. A pressure transducer connected to a Hermit® data logger was then inserted into the well casing to a depth of approximately 15 feet below the static water level. The water level in the casing rose slightly in response to the volume of water displaced by the probe and submersible pump; therefore, field personnel waited until the water level returned to the original static level to start the test.

After the water level equilibrated, the data logger was started and minutes later a slug of water was rapidly removed from the well using the submersible pump. The data logger recorded the depth to water level as it recovered to its original static level. Optimally, the slug caused a change in the water level of between 1 and 3 feet. Each test proceeded until the water level had

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risen at least 80 percent of the distance between the maximum drawdown achieved by the slug and the original static level.

A second procedure was utilized to perform the slug tests conducted at Wells 9-S, 9-I, 9-D, 10-S, 10-I, 10-D, 11-S, 12-S, 12-D and a re-test of Well 2-S. Prior to testing a static water level as recorded. A pressure transducer connected to a Hermit® data logger was securely installed in the test well and a second water level measurement taken to insure that the well had equilibrated following placement of this device. A positive displacement device (3-inch I.D. PVC pipe, capped at both ends and weighted with sand) was instantaneously inserted into the well resulting in at least a 2-foot rise in the water level. The data logger recorded data from the time of insertion until complete recovery to pre-test water levels or a maximum of 5 hours, whichever was appropriate. In Wells 2-S, 9-S, 10-S, and 12-S the recovery of water levels following removal of the plug was also recorded.

The water level versus time data for each slug test were stored in the memory of the data logger. At the end of each field day, the data logger was returned to the ERM offices where the water level versus time data were transferred to hard copy.

#### Step Drawdown Tests

Step drawdown tests were conducted on the shallow and intermediate Wells 2 through 8 and Well 3-D to determine the yield of each of the wells.

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Prior to testing, static water level measurements were recorded from each of the wells. A 4-inch I.D. submersible pump was lowered to approximately 5 feet above the bottom of the well. A pressure transducer connected to a Hermit® data logger was also lowered below the pump.

After equilibrium conditions were reached, the static water level was input to the data logger and the pump and data logger were started simultaneously. In most wells, an initial discharge rate of 1 gpm was employed, whereas the higher yielding wells were able to maintain a discharge rate of about 2 gpm. The data logger continuously recorded the drawdown in each well. Once the drawdown had leveled off, the discharge was increased by approximately 1 gpm. This practice of increasing the discharge was continued until the water level in the well could no longer be maintained.

The water level versus time data for each step test were stored in the memory of the data logger and analyzed graphically.

#### Constant Drawdown Tests

Wells 11-I and 11-D are flowing artesian wells, therefore in order to determine aquifer transmissivity and hydraulic conductivity, constant drawdown tests were conducted. In this method, the decreasing discharge of an uncapped flowing well was measured versus time. A test plug and valve apparatus was installed on each well. The well was allowed to equilibrate and build up pressure behind the valve for several hours, a time frame in which water levels would be expected to stabilize. The valve was opened and discharge from the well was accurately

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measured with a graduated cylinder and a stop watch. The test was continued until discharge rates stabilized.

### 3.2.3 Long-Term Pump Test

In May 1986, a long-term pump test was conducted on Well 5-S, a shallow bedrock well that could sustain a significant yield and had a measurable amount of DNAPL. The long-term pump test used a total of 17 observation wells, therefore the results were not biased by using the highest yielding well. This centrally located well had a total depth at the time of testing of 55.5 feet which included 25 feet of open borehole. The total depth of this well was 60 feet upon completion, however siltation had occurred prior to the test. The purpose of the long-term pump test was to better define the hydrogeologic characteristics of the bedrock ground water system and to determine if ground water quality varied with pumping. The results from the test were also used for locating the additional downgradient and lateral well nests. The test was conducted prior to the installation of Well Nests 9 through 12.

To determine an appropriate pumping rate for the long-term test, a short-term step test was conducted on Well 5-S two days before the initiation of the 7.7 day pump test. Immediately prior to the onset of the pump test, static water levels were measured in all bedrock wells that had been installed by ERM, as well as accessible overburden wells that had been installed as part of earlier EPA work at the site. In addition to recording ground water levels, surface water levels at staff gauges and weirs in the Schuylkill River, drainage channels, and the swamp near the pumping well were measured, and are also shown on Plate 3.

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Throughout the pumping period, an average pumping rate of 9.0 gpm was maintained. Water levels were monitored in 17 observation wells using Hermit Data Loggers, which use pressure transducers to accurately measure ground water levels. Measurements were recorded at different frequencies depending on elapsed time, as shown below:

<u>Sample frequency</u>	<u>Elapsed time</u>
1 sec.	0-10 sec.
5 sec.	10-60 sec.
20 sec.	1-10 min.
2 min.	10-100 min.
60 min.	100-1,000 min.
200 min.	1,000-10,000 min.
>200 min.	10,000-99,999 min.

The ground water levels in all other bedrock wells were measured at least four times daily, whereas the overburden wells, staff gauges, and weirs were measured at least two times per day. DNAPL measurements in Well 5-S were frequently recorded throughout the pump test. Rainfall and barometric changes that could have influenced ground water levels were also recorded. Well 1, the background well, was monitored using a Stevens Recorder, a continuous recording device.

All equipment used in the pumping well was selected to be chemically compatible with suspected ground water contaminants. The equipment chosen included a stainless steel teflon-fitted submersible pump with a teflon-coated power cord. All ground

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water purged from the well was collected in 5,000-gallon tankers and then transported by Delaware Container to the E.I. duPont de Nemours & Co. treatment facilities in Deepwater, New Jersey for disposal.

To determine if any trends in ground water quality existed from the continuous pumping of Well 5-S, ground water samples were collected at 6- and 12-hour intervals from the pump discharge. Using a portable organic vapor analyzer with a gas chromatograph attachment, samples collected at 6-hour intervals were analyzed by ERM. The samples collected at 12-hour intervals were analyzed by Lancaster Laboratories. Analytical parameters and detailed sample handling procedures are outlined in Section 3.7.

On 21 May 1986 at 1100 hours, the pumping at Well 5-S was discontinued. Recovery data was collected for two days, applying the same logarithmic schedule that was employed for sampling drawdown data.

#### 3.2.4 Ground Water Sampling

Ground water samples were collected from each of the 33 bedrock wells and 11 overburden wells previously installed by EPA. Water quality results from these wells will determine the existence and nature of any ground water contamination.

Water level measurements were taken in every well prior to well evacuation. One to three well volumes were evacuated prior to sampling, depending on the recharge capacity of the well. Although it was desirable to remove three well volumes prior to

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sampling, many of the wells were pumped dry before three volumes could be removed.

A submersible pump was used to purge the bedrock wells. After the removal of an appropriate amount of water, a closed cell apparatus was connected to the pump discharge. Within the cell, pH, specific conductance, and temperature of the ground water were measured. The cell was used to minimize the interference caused by the atmosphere with measuring pH and specific conductance. Difficulty was experienced measuring pH using that method. This difficulty was thought to be caused by streaming potential due to the velocity at which the water entered the cell.

Because the purging of the 2-inch diameter overburden wells was accomplished by bailing, the field parameters (pH, specific conductance, and temperature) were measured from water that was transferred from the bailers into precleaned beakers.

Based on the preliminary water quality results, a sampling sequence was established so that the least contaminated wells would be sampled first and the most contaminated would be sampled last. The submersible pumps used for purging were steam cleaned between wells and the check valve in the pump prevented backflow. The possibility of cross-contamination between wells was minimized by following these steps.

Dedicated precleaned stainless steel bailers were used for obtaining samples from the bedrock wells. PVC bailers were used for sample collection from the PVC overburden wells.

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All samples collected for metals analysis were filtered through a 0.45 micron pore-sized membrane and transferred into bottles previously spiked with dilute nitric acid preservative. The filtration apparatus was rinsed with dilute nitric acid, acetone, and distilled water between each use. A Millipore filtering system was used.

A total of five duplicate samples and five samples used for matrix spikes were collected to satisfy QA/QC requirements. Additionally, field blanks accompanied all samples during sample collection and in transit to the laboratory. Analytical parameters and detailed sample handling procedures are outlined in Section 3.7. EPA's over-site contractor (NUS) accepted seven split samples (Wells 1, 3-S, 3-D, 7-S, 7-D, 8-S, and 8-D).

#### 3.2.5 DNAPL Recovery Tests

Before describing the DNAPL recovery tests, it is important to note that the presence of DNAPL was first discovered in Well 8-I during drilling and other wells only after the wells had been developed or pump tested. DNAPL was not detected during well development in wells other than Well 8-I. The point of entry for DNAPL into the open interval of Well 8-I could not be determined. Elevated organic vapor meter (OVM) measurements could occur from the presence of the DNAPL or high dissolved phase volatile organics making the exact point of entry impossible to determine by these measurements.

The function of the DNAPL recovery test was to determine the physical dynamics, distribution, and recoverability of DNAPL in the bedrock aquifer for the purpose of identifying potential

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remedial alternatives. The greatest thickness of DNAPL was found in Well 8-I and the testing was designed using this well. Well 3-I, selected because of its measurable DNAPL and proximity to the former waste lagoons, was also tested using similar methods. The DNAPL test consisted of three phases: sample collection, purging of DNAPL, and reduction of static head. The tests at Wells 8-I and 3-I were not conducted simultaneously.

Using a 2-inch PVC bottom loading bailer, a sample of DNAPL was collected from the bottom of each of the wells in April and September, respectively. Each sample was placed into a 1-liter wide-mouthed glass jar with a teflon septum. To avoid dilution of the sample, all of the water was decanted off the DNAPL before the jar was sealed. Employing the sampling protocol outlined in Section 3.7, the DNAPL samples were sent to Lancaster Laboratories for the following analyses: specific gravity, Brookfield Viscosity, and solvent screen. Because results of earlier sampling efforts indicated that 1,2,3-trichloropropane was a probable major component of the DNAPL, a specific analysis for this organic compound was included in the solvent screen.

The second segment of the DNAPL Recovery Test was the withdrawal of DNAPL from the bottom of each of the wells. Before the DNAPL was extracted, the static DNAPL levels were recorded. An air-activated purge pump constructed by ERM was used to pump all of the DNAPL from the bottom of the borehole. This type of pump was selected because it was not prone to mechanical failure (has no moving parts). Earlier efforts to pump the DNAPL using conventional pumps failed due to the corrosive nature of the DNAPL. During the purging and up to 24 hours following purging

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the thickness of DNAPL in the well was measured at regular intervals.

The final stage of the DNAPL Recovery Test was the reduction of hydrostatic head using submersible pumps. This was conducted to determine if measurable changes in DNAPL thicknesses could be correlated to the reduction in static head. The pump was lowered into the well using a winch, which also allowed for the ready adjustment of the pump within the well as needed. At the initiation of the tests, the pump intake was within the cased portion of the well. However, because of the low yield of both wells, the pump intake was lowered to keep it below the pumping level. Because of the corrosive nature of the DNAPL and of the ground water within Well 8-I, an all stainless steel, viton-bearing, teflon-sealed submersible pump was used in the testing of Well 3-I. In addition, a teflon-coated power cord was installed on this pump. A .75-inch I.D. PVC tube was installed in each well from the top of casing to approximately 5 feet off the bottom of the well. A conductivity probe for measuring the thickness of DNAPL was inserted into the tube. This enabled accurate measurements of DNAPL thickness free of potential inaccuracy created by pumping turbulence. The thickness of DNAPL was measured at regular intervals throughout the test and up to several days after pumping stopped.

An additional sample of DNAPL was collected in March 1987 to determine whether it exhibited the characteristics of a hazardous waste based on corrosivity, reactivity, and ignitability. The DNAPL sample was collected from Wells 5-S and 3-I with a new bottom loading PVC bailer which had been rinsed with deionized water. DNAPL was not present in Well 8-I in a large enough

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quantity to also composite in this sample. The DNAPL sample from Wells 3-S and 3-I was then composited into two 1-liter wide mouth glass bottles with teflon septa, analyses were completed for corrosivity, ignitability and reactivity.

### 3.2.6 Well Inventory

An inventory of all identifiable residential, commercial, industrial, and public supply water wells within a 3 mile radius of the site was completed in July, 1986 (Plate 4). The purpose of the inventory was to identify those wells which may serve as potential future monitoring points. Available information was obtained concerning well owners, well depth, use of the well, yield in gallons per minute (gpm), the formation in which the well was finished, date drilled, if the well is presently in use and if any well logs are available. ERM also gathered information from other residential sampling efforts conducted by EPA subcontractors and PA DER to minimize sampling duplication. The following agencies were sources of information for this task:

1. Pennsylvania Department of Environmental Resources,  
Bureau of Topographic and Geologic Survey Water Well  
Data System
2. Pennsylvania Department of Environmental Resources,  
State Water Plan
3. Norristown Public Works - Sewage Accounts
4. Philadelphia Suburban Water Company

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5. Keystone Water Company - piping distribution map
6. United States Department of the Interior
7. Environmental Protection Agency
8. United States Geological Survey

#### 3.2.7 Schuylkill River Sediment and Bottom Water Sampling

An investigation of the Schuylkill River was deemed necessary because of the presence of elevated concentrations of volatile organic compounds in well nests adjacent to the river and the role of this river as a major regional ground water discharge point. The purpose of this investigation was to determine the river sediment and water quality and the hydraulic relationship between the river and the deep aquifer.

In October 1986, sediment and bottom water samples were collected to determine if contaminants had migrated into the river. Samples were collected at a total of 10 stations as shown on Plate 5, both sediment and bottom water samples were collected at stations A through I; only a sediment sample was collected at station J.

Station A, the original upriver station, was just off the western edge of Barbadoes Island. Station B was on the north side of Barbadoes Island and opposite Station E, which was structurally down dip of the site. Station C was also on the north side of Barbadoes Island and opposite Station F, which was approximately

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100 yards downriver of fracture trace D, which was discussed in Section 4.1.4. Station D was downriver of the PA American Water Treatment Plant effluent discharge and just upriver of the Norristown Dam. Station G was at the PA American Water Company intake, on the south side of Barbadoes Island and Station H was 2 miles upriver of the site, just below the Route 441 bridge. Station H was upriver of Abrams Creek which was the receiving stream to a well publicized gasoline spill unrelated to the site which had occurred in King of Prussia three days prior to this sampling effort. This station would serve as an additional background location should the spill have affected the water quality in the river. Station I was south of Barbadoes Island, 100 yards upriver of the Norristown Dam. A sediment sample only was collected at Station J.

The bottom water samples were collected utilizing a brass Kemmerer messenger sampler. Prior to sampling and between each sample, the Kemmerer sampler was decontaminated with an Alconox water solution and rinsed with deionized water. The depth to bottom at each sampling site was measured to the nearest 0.1-inch with a weighted tape.

Sediment cores were collected using Ocean Surveys, Inc.'s, specially constructed boat-mounted vibratory corer. The core barrel consisted of 3-inch diameter aluminum tubing. Prior to sample collection, each tube was steam-cleaned, washed with an Alconox water solution, rinsed with copious amounts of deionized water, and then sealed until sample collection. At each site, the core barrel was lowered to the river bottom at which time the vibratory mechanism (modified cement vibrator) was started. The core barrel was advanced to refusal, which is defined as less

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than 6 inches of penetration in a 5 minute period. The core barrel was then lifted manually into the boat and sealed at both ends. The gravelly nature of the Schuylkill River bottom occasionally resulted in no sample recovery. When this occurred, a second and, if necessary, third attempt was made within 100 feet of the initial coring site to complete sample collection. The core sample was removed from the core barrel and visually classified (i.e., texture, structure, composition) by an ERM geologist.

No more than 2 feet of core was retrieved from any location. Depending on the lithologies present in the core, the entire sample was either composited or samples of materials of differing lithologies were selected for analysis. A total of 14 samples were submitted from 10 sampling locations. Samples requiring compositing were mixed in a stainless steel bucket using a stainless steel trowel. Analytical parameters and detailed sample handling procedures are outlined in Section 3.7.

Upon analysis of the data from the October 1986 sediment and bottom water samples, it became apparent that additional bottom water samples should be collected to confirm the results of the October sampling. To this end, two sets of samples were obtained in February and March 1987 at stations A through I, with station J being sampled in March. Each of these samples were analyzed for HSL volatile organic compounds and 1,2,3-trichloropropane. Additional parameters were analyzed for at individual stations as discussed in Section 3.7.

In April 1987, additional sediment samples were collected at stations C, E, F, G, H, and J. These samples were collected with

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an Eckman bottom sampling dredge decontaminated following procedures outlined in Section 3.7. A 16-ounce wide mouth glass container with teflon septa and a 1-quart glass mason jar were filled at each location. Analyses were completed for total organic carbon and grain size distribution, respectively.

In February 1987, ERM received results from river water samples collected by EPA at the PA American Water Plant intake at Norristown and the Philadelphia Water Department intakes at Belmont and Queen Lane. These samples had 1,2,3-trichloropropane concentrations in the part per trillion (ppt) range. To confirm the presence of this trace level concentration, ERM obtained samples of river water at the PA American Water Plant intake and at upriver station H in ten 1-liter amber bottles in April, 1987. The samples were analyzed by performing a methylene chloride extraction and reduction of 10 liters of sample to a final extracted volume of 70 microliters and utilizing full scan GC/MS analyses as specified in EPA Method 625. The detection limit of this method was 7 ppt.

Subsequent to confirmation of trace level concentrations of 1,2,3-trichloropropane at the intakes, the Schuylkill River water sample collection was expanded to include sites both farther upriver and downriver of the Tyson's Site. In addition, water samples were also collected at the PA American Water Company and Philadelphia Water Company (Queen Lane and Belmont Plants) before (raw or untreated) and after treatment. Table 3-2 contains a description of each sampling site and each has been located on Plate 5. This sampling event was conducted on two days, 4 June and 16 June 1987.

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TABLE 3-2

TYSON'S SITE  
 SCHUYLKILL WATER SAMPLING LOCATIONS  
 FOR  
 1,2,3-TRICHLOROPROPANE ANALYSES  
 April and June, 1987

SITE IDENTIFICATION	LOCATION
Far Upstream	Valley Forge National Park - Pawlings (Road) Parking Area about 50 yards downstream of Pawlings Road Bridge.
Station H (upstream)	Valley Forge National Park - Railroad Station at the Betzwood Bridge (Rt. 422 crossing of Schuylkill River).
River Pt. #3 Norristown Raw	PA American Water Company, Norristown Water Supply Intake - untreated samples collected from middle tap of three in water quality lab under direction of water quality officer.
River Pt. #4 Norristown Treated	PA American Water Company, Norristown Water Supply treated water sample collected from right hand tap (out of three) under direction of water quality officer.
Station N	Bottom water sample collected at PA American Water Company Intake Crib in South Channel of the Schuylkill River.
Spring Mill	Spring Mill, PA, Septa train station parking lot off River Road.
Queen's Lane	Queen's Lane Water Treatment Facility, Philadelphia Water Company. Samples of untreated Schuylkill River water and treated drinking water obtained from water quality lab.
Belmont	Belmont Water Treatment Facility, Philadelphia Water Company. Samples of untreated Schuylkill River water and treated drinking water obtained from water quality lab.
Bartram Park	Far downstream sample collected at Bartram Park, Philadelphia, PA.
Linden Avenue	Located on Delaware River at Linden Avenue Park. Sample collected from a municipal dock.

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These river water samples were collected in 2 to 3 feet of water, 1 to 2 feet below the water surface. At each of the water treatment plants, treated and untreated river water samples were obtained from designated sampling points within the water quality departments of each facility under the direction of plant engineers.

At each location, three 40 ml glass vials with teflon septa were filled in such a manner as to eliminate headspace. During collection of each sample new gloves were donned to prevent cross-contamination between samples. The samples were analyzed for 1,2,3-trichloropropane by EPA Method 524.2 with a 10 ppt detection limit. Additional information on the analytical procedures and sampling methods are given in Section 3.7.

### 3.2.8 River Piezometer Installation and Sampling

During April 1987, temporary piezometers were installed to the top of bedrock at eight locations in the Schuylkill River adjacent to the site (Figure 3-4). The purpose of the piezometer installations was to determine the hydrogeologic relationship between the river and the deep aquifer and to determine the quality of ground water discharging from the deep aquifer to the river.

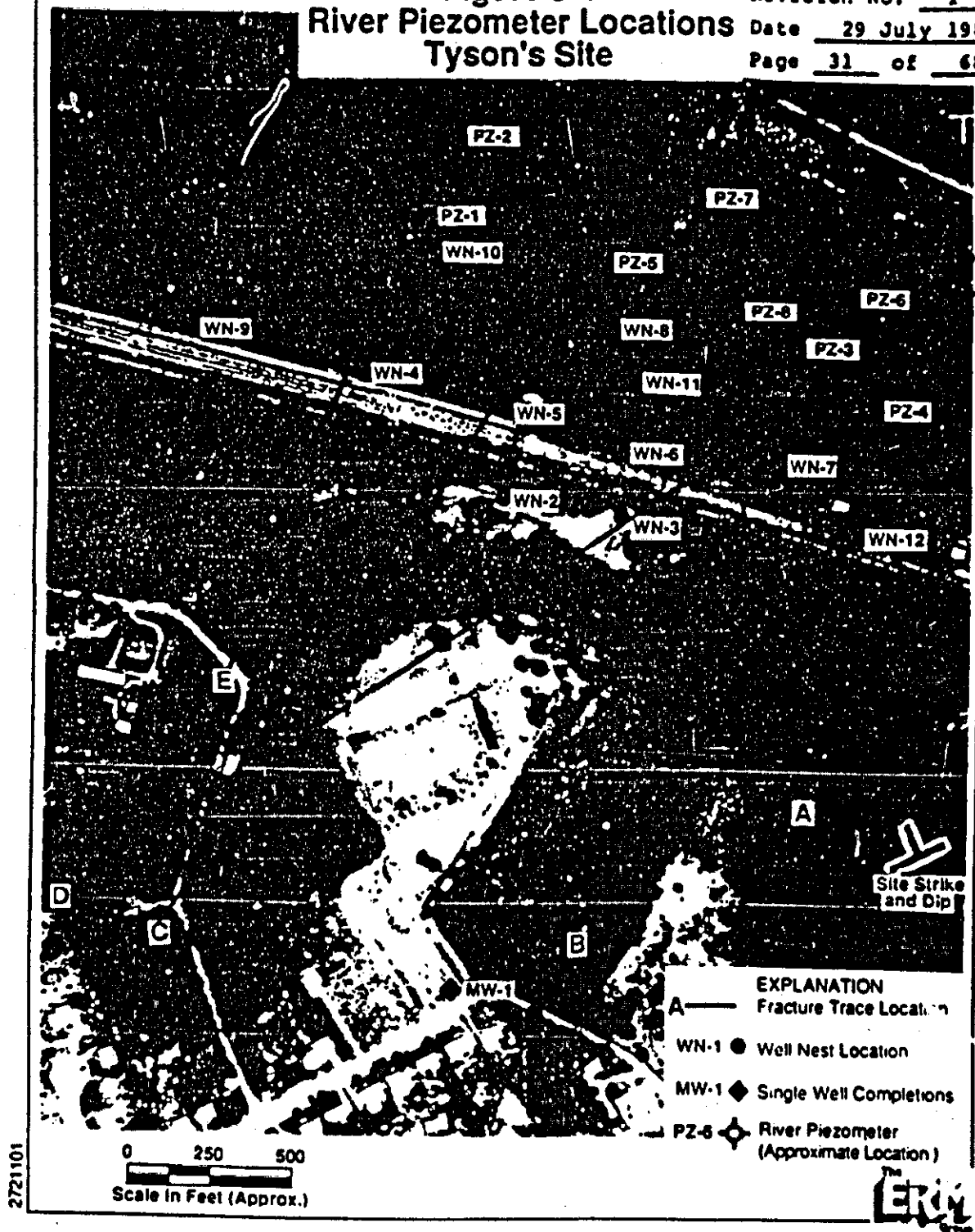
The piezometers were located when possible along fracture traces described in Section 4.1.4 to intercept potential ground water discharge points. With the use of a sledge hammer, each of the 1.5-inch I.D. custom designed 5- to 13-foot steel piezometers (Figure 3-5) were driven into the river bottom sediments between

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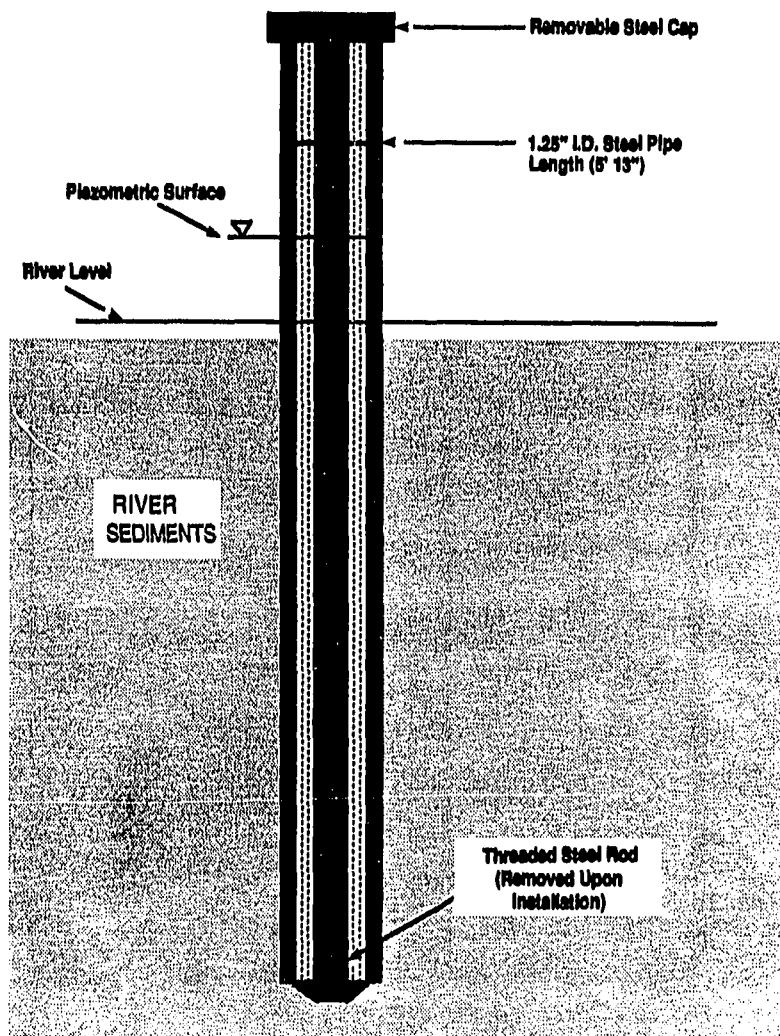
**Figure 3-4**  
**River Piezometer Locations**  
**Tyson's Site**

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**Figure 3-5**  
**River Piezometer Design**  
**Tyson's Site**

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approximately 1.5 and 10.0 feet. If piezometer length allowed, each piezometer was driven into river sediments to refusal, a depth which was thought to represent the weathered bedrock surface. At this time the internal steel rod was removed to allow ground water levels within the piezometers to equilibrate. Water levels were periodically measured in the piezometers, river staff gauges, and deep bedrock wells for two months.

Approximately two weeks following their installation each piezometer was sampled utilizing a 1-1/4-inch PVC bailer. Each bailer and piezometer were pre-cleaned with an Alconox/water wash, tap water rinse and deionized water rinses.

One volume of water was evacuated from each piezometer prior to sampling with the bailer. The samples were analyzed for HSL volatile organic compounds and 1,2,3-trichloropropane. Additional information on the analytical procedures and sampling methods are given in Section 3.7.

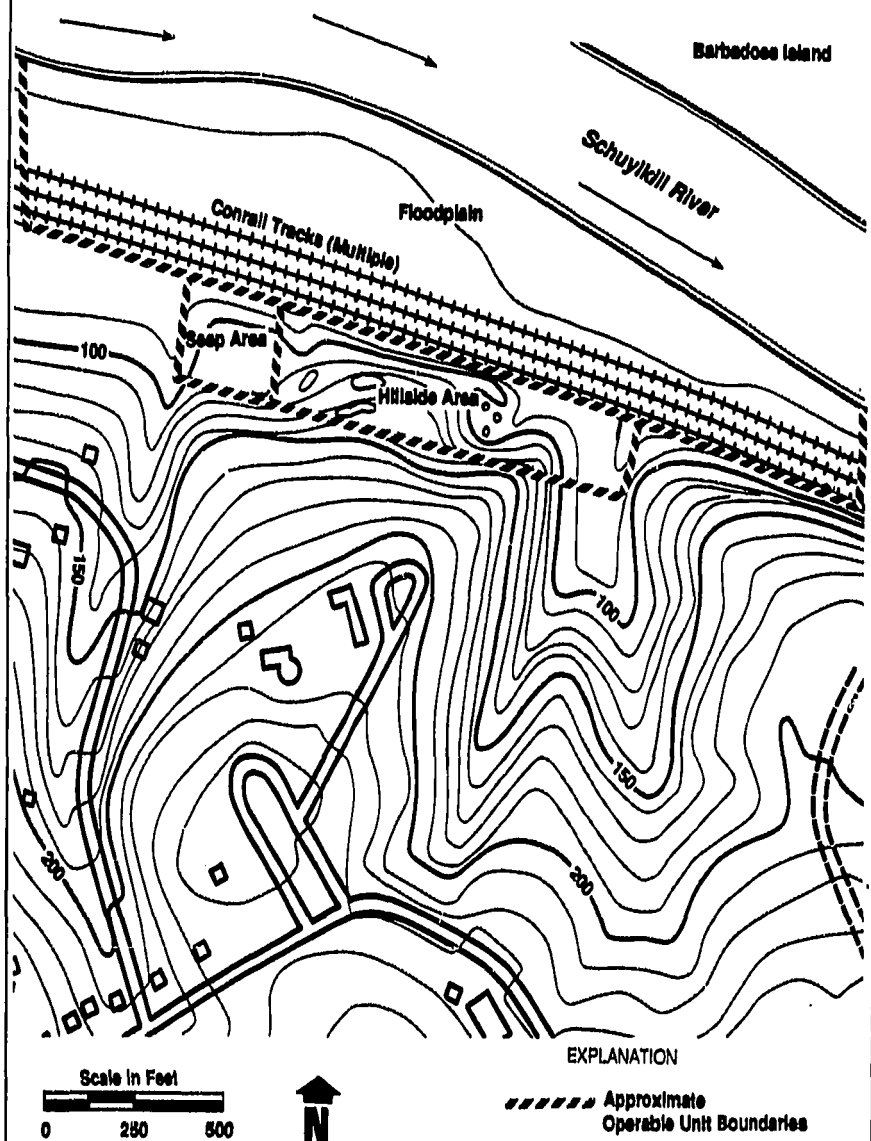
### 3.3 Hillside Area (Operable Unit 2)

The purpose of the hillside investigation was to determine if overflow from the former lagoon area had resulted in contamination of soils on the hillside between the lagoons and the railroad tracks. Samples were taken from eight areas that displayed evidence of erosion. One background sample was also collected (Figure 3-6).

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# **Figure 3-6** **Seep and Hillside Areas** **Tyson's Site**



Source: U.S.G.S. Topographic Quadrangle; Norristown, PA



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Samples from all locations were split with EPA's over-sight contractor, NUS. The soil samples were collected to eliminate the presence of extraneous organic matter such as twigs and leaves. This was done by removing overlying vegetation and leaf litter and collecting soil samples at a depth of about 3 inches. Each sample was collected using a stainless steel trowel, composited in a stainless steel bowl, and distributed in glass sample jars. All equipment was decontaminated between samples using rinses of Alconox solution, acetone, and distilled water. One duplicate and laboratory matrix spike sample was collected to provide quality control. Analytical parameters and detailed sample handling procedures are outlined in Section 3.7. Upon completion of the sampling effort, each of the sampling points was located by James M. Stewart, a licensed surveyor.

### 3.4 Railroad Area (Operable Unit 3)

#### 3.4.1 Soil Borings

A subsurface soil investigation was conducted in the Railroad Area in July 1986. This multi-depth sampling effort was designed to determine if reported seepage and run-off from the former lagoon area contaminated the soil and ballast beneath the tracks.

Twenty-eight soil samples were obtained from 10 soil borings, advanced to bedrock. Eight of the 10 soil borings were advanced using a 4-inch hollow stem auger rig mounted on an all terrain vehicle (ATV). Walton Corporation, Newark, Delaware, was the drilling contractor used for this task. Shallow bedrock on the south side of the tracks, plus the constricted work area at the

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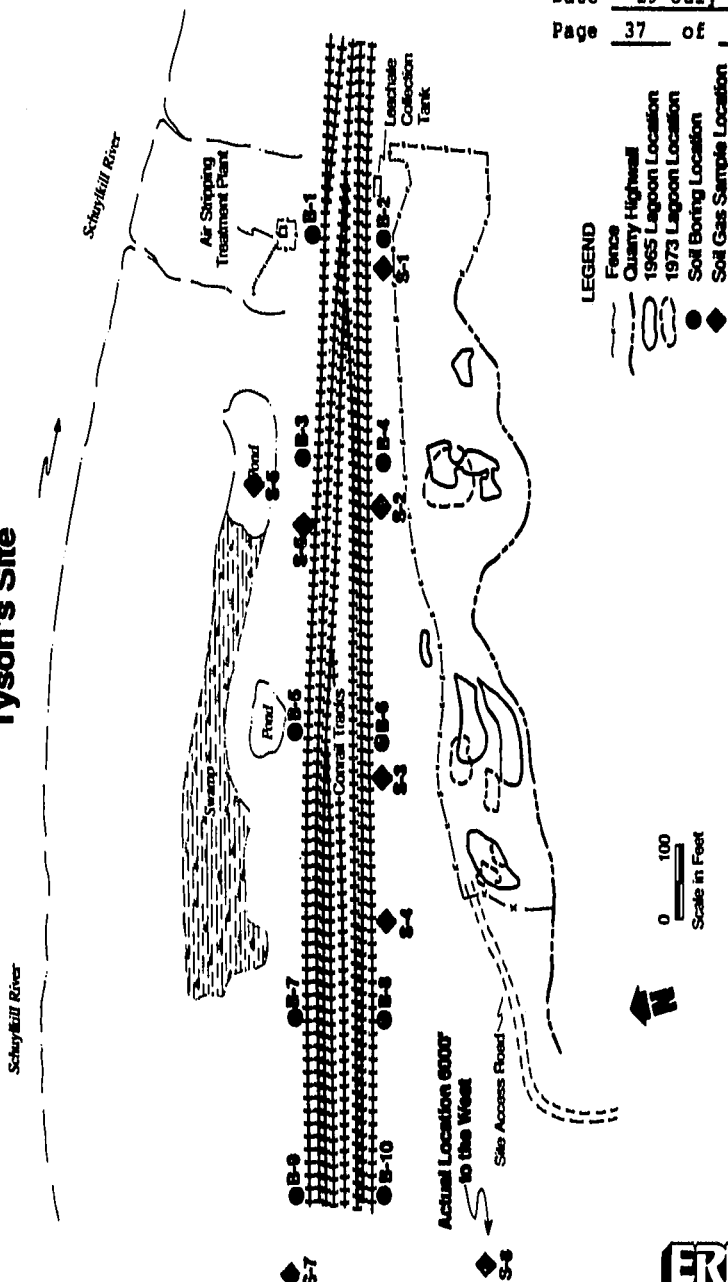
proposed locations for borings B-8 and B-10, made it necessary to advance these two borings by driving continuous split spoon samplers with a sledge hammer. All soil borings were advanced to auger or split spoon refusal. Upon completion, each soil boring was backfilled with cuttings to within 2 feet of the surface. The remaining 2 feet was filled with a cement/bentonite grout. Soil boring locations are given in Figure 3-7.

The subsurface soil samples were collected from the 10 soil borings according to the standard method for penetration sampling, ASTM D1586-67. Samples from the borings north of the tracks were taken at the 0-2, 4-6, 8-10, 12-14, and 20-22 foot depth intervals. Auger refusal in these borings was encountered in the range of 21.5 to 26.9 feet. Borings located on the south side of the tracks encountered auger refusal at considerably shallower depths, generally ranging from 3 to 10.9 feet. This shallow depth to bedrock made the sampling intervals more varied. When possible, samples were collected in the 8-12 foot interval and split with the EPA over-site contractor, NUS. Soils collected in the split spoons were composited in a stainless steel bowl until adequate volume was collected to fill the sample jars. Collection of split samples on the south side of the tracks was dependent upon the lithologies present and the depth of auger refusal. Soil samples from the boring program were split with the EPA over-sight contractor. Three duplicate samples and three samples for laboratory matrix spikes were collected to provide quality control. Analytical parameters and detailed sample handling procedures are outlined in Section 3.7.

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**Figure 3-7**  
**Soil Boring and Soil Gas Sampling Locations**  
**Railroad Operable Unit**  
**Tyson's Site**



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The auger rig and all downhole tools were steam cleaned at the beginning of field operations and between borings to prevent cross-contamination of samples. All split spoon samplers were steam-cleaned, washed in an Alconox solution, and rinsed with acetone and deionized water before each use.

#### 3.4.2 Soil Gas Analyses

The initial Work Plan included only soil sampling along the railroad tracks. However, the discovery of elevated levels of organic compounds in the bedrock aquifer and elevated OVM readings while drilling through the unconsolidated material at Well Nests 4, 5, and 6 required that the contamination in this area be better defined.

In July 1986, soil gas analyses of vapor samples taken from shallow boreholes along the sides of the track area was conducted using a portable gas chromatograph (GC) technique to obtain qualitative and semi-quantitative information.

The intent of this task was to provide additional data in the railroad tracks where the auger rig could not operate. However, it was impossible to hand auger through the railroad ballast material, and Conrail access restrictions made it impossible to use hand power augering equipment. Therefore, borings were augered at locations near the rig-mounted augered borings discussed in Section 3.4.1 (Figure 3-7).

Three borings (S-1, S-2, and S-3) were augered to a depth of 36 to 48 inches using a 3.5-inch diameter power auger. The exact location and depth of the borings depended upon the soil types or

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fill material encountered. Soil gas samples were collected for these three locations through a gas probe inserted into each boring. A gas-tight syringe was used to remove a sample from the probe via a septum port. The sample was then injected into the calibrated GC and after the last compound of interest had eluted, the column was backflushed with hydrogen to remove any heavier molecular weight compounds still on the column. Following the backflushing, blanks of the column, syringe, and probe were analyzed.

The remaining five borings (S-4 through S-8) were augered to a depth of 36 to 48 inches with a 1-inch stainless steel hand auger. Soil samples from the bottom of the boring were collected at these locations for possible portable GC headspace analysis under controlled conditions.

The soil gas probe was designed after Dr. Thomas M. Spittler's model (U.S. EPA Region I). The probe consisted of a 1-foot by 4-inch PVC pipe cemented into a PVC cap and is depicted in Figure 3-8. The cap was fitted with a .25-inch septum port and .25-inch Tygon tubing connected to an Analytical Instrument Design (AID) Organic Vapor Analyzer (OVA) which served as a vapor pump and allowed for total VOC monitoring. After sampling, the PVC probe and cap were decontaminated with an Alconox wash, tap water, acetone, and deionized water rinses.

The OVA equipped with an Flame Ionization Detector (FID) was used to indicate when maximum soil gas concentrations existed in the probe. Soil gas samples were collected via the probes septum port when the maximum OVA reading was obtained. A Foxboro OVA

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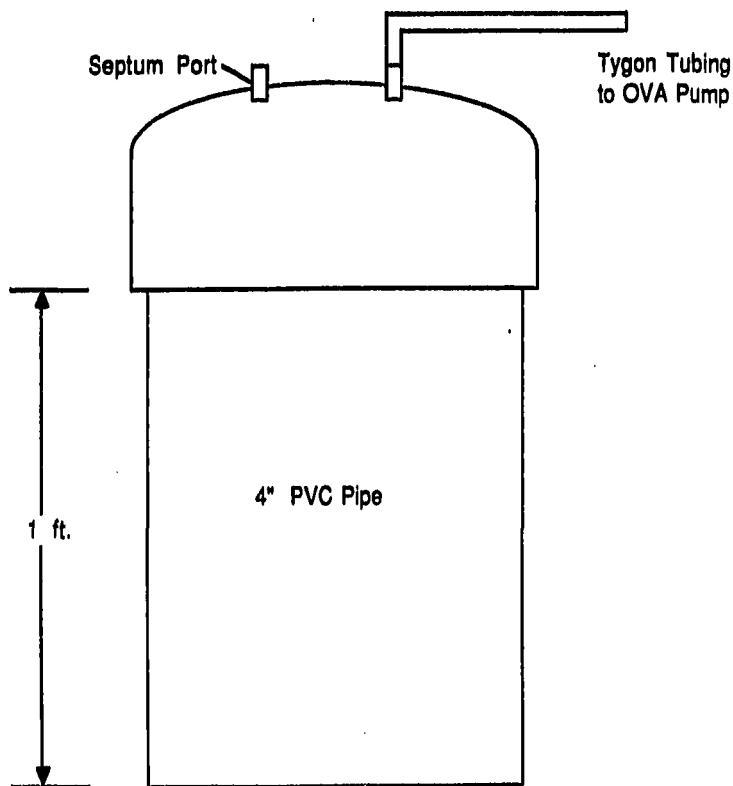
# Figure 3-8 Soil Gas Probe Schematic Tyson's Site

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128 with a GC attachment was then used in the field to chromatogram the soil gas vapors. The OVA 128 GC has a FID, utilizing hydrogen and ambient air as carrier gases and has an injection port attachment for headspace/gas analysis.

A 1-foot by 1/8-inch PVC column packed with 10 percent OV-101 on Anakrom Q, 60-80 mesh and fitted with an isothermal pack for a constant 40°C temperature was used to detect aromatics and chlorinated hydrocarbons. A series of Hamilton gas-tight syringes (10 ul to 250 ul) collected the sample from the soil gas probe for injection into the GC column.

A series of 1,2,3-trichloropropane (TCP) standards, prepared on a volume/volume basis from a neat standard were used to initially calibrate the GC. An appropriate level standard was re-analyzed, as necessary, depending upon the soil gas concentration. Retention time matching for TCP qualitative identification and peak height analysis for quantification was attempted for the three soil gas sampling locations.

A detailed record was maintained of the boring location, fill or soil type, boring depth, soil gas equilibration time, injection number of each sample or blank, injection volume, GC attenuation, standard concentration, run time for each injection, backflushing time, climatic conditions each day, and any peculiarities noted in the chromatograms.

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### 3.5 Floodplain/Wetlands Area (Operable Unit 4)

An investigation of the floodplain/wetlands area located between the former lagoon area and the Schuylkill River was conducted to obtain information on the extent and severity of contamination in this area and its potential effect on biota.

This investigation included five subtasks:

- field reconnaissance,
- environmental sampling,
- determination of the environmental mobility of organic, constituents,
- bio-accumulation study, and
- bioassay studies.

#### 3.5.1 Field Reconnaissance

In June 1986, a reconnaissance to qualitatively inventory the vegetation and wildlife in the floodplain areas was conducted. A total of seven transects were walked from the railroad right-of-way to the bank of the Schuylkill River. Observations made along the transects were recorded. Appropriate field guides were employed for plant identification. Wildlife was assessed based on actual observation and, for mammals, observation of spoor or scat in addition to actual observation. Observations made on 16 June were supplemented by additional observations made during the conduct of other field investigations, primarily collection of specimens as part of the bioaccumulation studies.

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Transect routes are presented in Plate 6. The seven transect routes are described in Table 3-3.

During the reconnaissance, as well as during subsequent field work, areas where vegetative stress might be apparent were examined. Typical indicators of vegetative stress included denuded areas, stunted growth, chlorosis (yellowing), excess deadwood (trees and shrubs), and canopy density (overstory). A qualitative assessment based on previous experience in similar systems as well as comparison to areas in the floodplain removed from potential impact was applied. The field studies were complimented by analysis of infrared aerial photographs of the site taken in 1970 and 1980.

#### 3.5.2 Environmental Sampling

Additional investigations were conducted on the floodplain to determine if overland flow, seeps, and springs originating from the former lagoon area had resulted in contaminant transport onto the floodplain and potentially to the river. Two sampling events were conducted to determine seasonal variation as a result of periods of high and low runoff.

The first sampling event was conducted in March 1987 with high seasonal precipitation and associated runoff. Four surface water and sediment samples were collected from intermittent streams as shown on Plate 7. Three of these streams drain into the river, and the fourth originates from a spring and enters a drainage ditch which directs flow beneath the railroad tracks onto the floodplain.

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TABLE 3-3  
TRANSECT LOCATION DESCRIPTIONS

<u>Transect Number</u>	<u>Description</u>
1	Vicinity of railroad control tower
2	Swale in vicinity of propane storage tanks
3	Stream receiving air stripper effluent
4	Swamp/Pond Area to vicinity of Well Nest 8
5	Railroad signal tower to river
6	Area immediately west of area designated as wetland
7	Approximately 70m west of the Transect 6, beginning at culvert/swale

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Also, in March 1987, five surface soil samples were collected at various locations (Plate 7) on the floodplain to determine the physical nature of these sedimentary deposits. Only analyses for total organic carbon and grain size distribution were completed on these samples.

By late April 1987 seven weirs (Plate 7) had been installed at discharge points along the floodplain. The weirs were constructed of wood, 3 to 6 feet long and each was fitted with a PVC pipe (2- to 4-inch diameter). The flow rate at the discharge points was recorded throughout the months of May and June.

In June, 1987, a second round of runoff samples were collected during a period of low runoff. At this time only the stream downgradient of the air stripper outfall could be sampled as the other intermittent tributaries were not flowing. The spring was not resampled because flow from the spring onto the floodplain was considered minimal, therefore the initial water quality and flow data was sufficient for characterization. At this time, samples of the influent and effluent from the USEPA installed air stripper were also obtained.

During the collection of soil samples care was taken to eliminate the presence of organic matter such as leaves and twigs. Analytical parameters and detailed sample preparation, preservation, and storage procedures are outlined in Section 3.7.

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### 3.5.3 Biological Studies

#### 3.5.3.1 Scope of Work

The biological studies included the following subtasks:

- A field reconnaissance
- Collection of environmental samples
- An evaluation of the environmental mobility of organic chemical constituents
- A bioaccumulation study
- Large volume acute and chronic bioassays using leachates generated from sediments obtained from three stations in the floodplain/wetlands area
- Additional sediment toxicity bioassays

Conduct of the additional sediment toxicity bioassays was in response to the comments on the draft Off-Site Operable Unit RI submitted to EPA on 8 December 1986.

#### 3.5.3.2 Environmental Mobility of Organic Chemical Constituents

An evaluation was conducted to determine the environmental mobility and migration potential of organic compounds identified

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at the site. This assessment included organic compounds detected during the EPA's On-Site RI/FS and ERM's Off-Site Operable Unit RI (Table 3-4). The environmental mobility assessment was based upon literature values for octanol/water partition coefficients ( $K_{OW}$ ) and soil/sediment absorption coefficients ( $K_{OC}$ ). This approach was valid since the floodplain soils contained significant amounts of organic materials. Solubilities of compounds were used to calculate missing  $K_{OC}$  as follows:

$$\text{Log } K_{OC} = (-0.55 \text{ Log Solubility}) + 3.64 \text{ (USEPA 1985)}$$

(Superfund Public  
Health Manual)

No exotic compounds (excluding the tentatively identified compounds) were found in either RI study and thus, the UNIFAC model was not used. This assessment identified a list of potential bioaccumulators which were evaluated during the floodplain investigations.

#### 3.5.3.3 Bioaccumulation Studies

Background and downgradient samples of a wetland plant (jewelweed), an aquatic invertebrate (Asiatic clam) and an aquatic vertebrate (snapping turtle) were collected to determine whether contaminants had entered the wildlife and human food chain. These data were intended for use in an environmental risk assessment which would be incorporated into the Off-Site Operable Units Endangerment Assessment (EA). The sampling locations for the jewelweed (Impatiens capensis), clams (Corbicula manilensis), and snapping turtles (Chelydra serpentina) are shown on Plate 8.

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TABLE 3-4.  
DETERMINATION OF ENVIRONMENTAL MOBILITY FOR  
ORGANIC COMPOUNDS DETECTED DURING THE EPA ON-SITE AND ERM FLOODPLAIN INVESTIGATIONS.

COMPOUND	K <sub>ow</sub>	K <sub>oc</sub>
2-CHLOROPHENOL	1.81E+02	7.30E+01
2,4-DIMETHYLPHENOL	2.00E+02	9.80E+01
PHENOL	3.00E+01	1.42E+01
3-METHYLPHENOL	9.33E+01	1.48E+01
4-METHYLPHENOL	9.33E+01	1.48E+01
ACENANTHENE	9.60E+03	4.80E+03
1,2,4-TRICHLOROBENZENE	1.80E+04	9.30E+03
2-CHLORONAPHTHALENE	1.00E+04	4.80E+03
1,3-DICHLOROBENZENE	9.80E+03	1.70E+03
1,3-DICHLOROBENZENE	9.80E+03	1.70E+03
1,4-DICHLOROBENZENE	9.80E+03	1.70E+03
FLUORANTHENE	7.80E+04	3.80E+04
ISOPHORONE	1.80E+02	8.70E+01
NAPHTHALENE	1.98E+03	9.40E+02
NITROBENZENE	7.40E+01	3.80E+01
N-NITROBIS(4-PHENYL)AMINE	1.38E+05	6.48E+02
BIS(2-ETHYLHEXYL)PHTHALATE	4.10E+08	2.00E+08
DI-N-BUTYL PHTHALATE	3.80E+08	1.70E+08
DI-N-OCTYL PHTHALATE	7.40E+09	3.80E+09
PYRENE	6.00E+04	3.80E+04
ANILINE		1.40E+01
3-METHYLNAPHTHALENE		7.18E+02
BENZENE	1.30E+02	6.80E+01
CHLOROBENZENE	6.80E+02	3.30E+02
ETHYLBENZENE	2.30E+03	1.10E+03
METHYLENE CHLORIDE	1.82E+01	8.80E+00
FLUOROTRICHLOROMETHANE	3.31E+08	1.88E+02
TETRACHLOROETHENE	7.88E+02	3.84E+02
TOLUENE	6.80E+02	3.00E+02
TRICHLOROETHENE	2.80E+02	1.38E+02
O-XYLENE	1.82E+03	2.40E+02
4,4'-DDE	9.10E+08	4.48E+08
4,4'-DDD	1.80E+08	7.70E+08
1,1-DICHLOROETHANE	6.30E+01	3.00E+01
CHLOROPYRIM	9.10E+01	4.40E+01
TRANS-1,3-DICHLOROETHENE	1.23E+02	5.80E+01
TRANS-1,3-DICHLOROPROPENE	1.00E+02	4.80E+01
VINYL CHLORIDE	1.70E+01	8.20E+00
ALDRIN	2.00E+08	9.80E+04
4,4'-DDT	6.10E+08	3.80E+08
ENDOSULFAN I	2.50E+02	9.80E+03
ENDOSULFAN II	2.50E+02	9.80E+03
HEPTACHLOR	2.80E+04	1.20E+04
ALPHA-BHC	7.80E+03	3.80E+03
GAMMA-BHC	7.80E+03	3.80E+03
BENZOIC ACID	7.40E+01	3.88E+01
PHENANTHRENE	2.80E+04	1.40E+04
PCBs	1.40E+07	6.70E+06
DIETHYL PHTHALATE	2.88E+02	1.42E+02
BENZO(A)ANTHRACENE	4.10E+06	2.10E+06
BENZO(B)FLUORANTHENE	1.18E+06	5.80E+06
CHRYSENE	4.10E+06	2.00E+06
ANTHRACENE	2.80E+04	1.40E+04
DIELDRIN	3.80E+03	1.70E+03
CHLORDANE	3.00E+06	1.40E+06
BETA-BHC	7.80E+03	3.80E+03
DELTA-BHC	1.40E+04	6.80E+03
N-NITROBIS(4-N-PROPYL)AMINE	3.10E+01	1.50E+01
BENZO(A)PYRENE	1.18E+06	5.80E+06
BENZO(K)FLUORANTHENE	1.18E+06	5.80E+06
BENZO(GH)PERYLENE	3.20E+06	1.80E+06
FLUORENE	1.80E+04	7.30E+03
DIBENZO(A,H)ANTHRACENE	6.80E+06	3.30E+06
INDENO(1,2,3-CD)PYRENE	3.20E+06	1.80E+06
1,2-DICHLOROPROPANE	1.06E+02	5.10E+01
ACETONE	5.75E+01	2.20E+00
4-METHYL-2-PENTANONE		1.99E+01

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TABLE 3-4. CONTINUED  
DETERMINATION OF ENVIRONMENTAL MOBILITY FOR  
ORGANIC COMPOUNDS DETECTED DURING THE EPA ON-SITE AND ERM FLOODPLAIN INVESTIGATIONS.

COMPOUND	K <sub>ow</sub>	K <sub>oc</sub>
HEPTACHLOR EPOXIDE	4.80E+02	2.50E+02
BUTYL BENZYL PHTHALATE	3.60E+02	1.70E+02
2-BUTANONE	2.80E+01	4.80E+00
1,1,2,2-TETRACHLOROETHANE	2.40E+02	1.10E+02
CAPROIC DISULFIDE	2.00E+00	9.40E+01
2-HEXANONE		1.80E+01
1,1,1-TRICHLOROETHANE	3.80E+02	1.52E+02
CIS-1,3-DICHLOROPROPENE	1.00E+02	4.80E+01
1,2,3-TRICHLOROPROPANE		8.80E+01
ACENAPHTHYLENE	8.10E+03	2.80E+03

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Spotted jewelweed was substituted for the originally proposed Carex based on distribution throughout the operable unit as well as in a control area to the west of the site. Approval for the substitution was obtained from USEPA Region III (Verbal approval, Libby Rhodes - Environmental Impact and Marine Policy Division - 29 July 1986).

The jewelweed background samples were taken from a location to the west of the icehouse which is west of the former lagoons. Downgradient plant samples were taken from two locations; the swamp/pond area and the area immediately below the air stripper discharge.

Clams were collected at two locations; immediately downriver of the railroad bridge in Bridgeport (an area known to be harvested for clams) and upriver of the site at the upriver tip of Barbadoes Island. The downriver location is downriver of the Norristown Dam. Attempts to collect clams from other locations were not productive. The clams prefer a coarse, silt free substrate which was only found at the tip of the island and downriver of the dam. Collection of the clams and turtles required a collector's permit from the PA Fish Commission (Appendix D).

Initially, attempts were made to capture snapping turtles from the swamp/pond area immediately north of the former lagoons. However, this area did not support a population of snapping turtles. The pond had a limited volume of water during most of the year. The ephemeral nature of the pond water also limited the turtle's aquatic food supply. Two sampling locations were

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set up on the Schuylkill River; upriver of Barbadoes Island and at the south bank of the river adjacent to Well Nest 8.

A 2.6 kg, less than 5 year old female snapping turtle with a shell length of 22 cm and width of 23 cm was captured at the downriver location (adjacent to Well Nest 8). The upriver or control specimen was a 8.8 kg, less than 10 year old male with a shell length of 34 cm and width of 36 cm. Both turtles were sacrificed by freezing and subsequently autopsied by Dr. Deborah M. Gillette D.V.M., Ph.D., University of Pennsylvania - New Bolton Center - Department of Pathology, in September 1986. Samples of both fat and muscle tissue from both turtles were submitted for analysis.

All of the analyses were conducted by Hazelton Laboratories, an EPA CLP (Contract Laboratory Program) laboratory, Madison, Wisconsin, following EPA protocols for the analysis of environmental samples. All of the samples were analyzed for the HSL organic compounds. These compounds were selected based upon their presence within the former lagoon area and their ability to bioaccumulate.

#### 3.5.3.4 Large Volume Acute and Chronic Bioassays

Three large-volume composite sediment samples were collected for use in the acute and chronic bioassay studies that were conducted by the Academy of Natural Sciences of Philadelphia (Academy). These included one background composite sample from west of the site, one composite sample from the western swamp area, and one composite sample from the air stripper outfall ditch. These locations are shown on Plate 8. Soils used to generate the

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leachate were collected in two phases because large soil volumes were required and the Academy could only operate two tests at a time. During the first phase of sampling, a large composite sample from the west side of the background site was collected for leachate generation along with two small grab samples which were analyzed to provide chemical data for the next two bioassay tests. A subsample of the composite background sample was also taken for analysis.

The background leachate and a reference toxicant supplied by EPA were tested first. The second phase consisted of tests conducted from leachates generated from the composite samples taken at the air stripper outfall and western swamp.

Each of the large composite soil samples from the three areas were collected by shovel, put into a 16-quart stainless steel bucket, thoroughly mixed, and transferred to 55-gallon stainless steel drums. Four full buckets accounted for the entire composite sample from each area. Samples were driven immediately after collection by an ERM geologist to the Academy in Philadelphia, Pennsylvania.

The Academy's Bioassay Laboratory performed eight definitive bioassays on leachate samples and a reference toxicant obtained from EPA. For each leachate and the reference toxicant, the Academy ran a short screen test and the definitive 21-day chronic test with Daphnia magna, conforming to guidelines published by the EPA in The Federal Register (40 CFR, Paragraph 797.1330), and a screen test definitive 7-day growth test with the fathead minnow Pimephales promelas, conforming to guidelines published in EPA/600/4-85/014. The Daphnia tests were run at 20°C, and the

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fish test at 25°C. These temperatures are those required by the methods used. The photoperiod was 16 h light and 8 h dark. Because of the volatile nature of the compounds present at the site, chronic tests were continuous flow rather than static renewal. The reference toxicant was sodium lauryl sulfate obtained from EPA's Environmental Monitoring and Support Laboratory, (Cincinnati, Ohio). The response of animals to this compound was tested by a 48-hour acute Daphnia test and a 96-hour test of Pimephales larvae growth.

Unfortunately, the correct reference toxicant concentrations for the fish tests were not used. Acute endpoints seldom correlate with chronic endpoints and since chronic tests were being performed the reference toxicant tests should have been related to a known chronic effect. When selecting the test concentrations the Academy of Natural Sciences proceeded under the assumption that chronic endpoint data existed for the fathead minnow larvae exposed to sodium lauryl sulfate. Unfortunately, these data were not available and because of the time constraint in completing the bioassays, the test could not be rerun.

The leachates were generated using the "Standard Test Method for Shake Extraction of Solid Waste with Water"; ASTM: D 3987 - 85. Soil samples were weighed and added to dilution water (Academy of Natural Sciences Laboratory Grade Water) which was collected from Round Valley Reservoir, a pump-storage, oligotrophic reservoir located in central New Jersey. This water was used instead of Schuylkill River water because of the possibility of background organic contaminants in the river water. Fresh dilution water was collected on July 1, August 11, September 10, October 1, October 23, and November 6, 1986. The dilution water

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was chemically analyzed for pH, alkalinity, hardness, metals, and pesticides. Dilution water was filtered and autoclaved prior to the Daphnia tests but not for the fish larvae test. This treatment eliminated other microcrustaceans that could prey on the Daphnia or that may be confused as juvenile daphniids. The sediment samples were agitated for 18 hours in a motorized, rotating agitator constructed following recommendation of the above ASTM guideline. The agitator was maintained at 29 revolutions per minute (rpm). After agitation, the samples were allowed to settle, and the fluid solution containing suspended silts and clays was centrifuged by continuous flow to remove solids. This leachate was stored overnight in the test room to bring the water to the test temperature, and was used immediately thereafter for the bioassay. A new batch of leachate was prepared each day and was supplied to the test chambers using a continuous flow pump system.

Continuous flow centrifugation was performed with a Sorvall KSB continuous flow system on a Sorvall Model SS-3 Superspeed Centrifuge or a Sorvall RC5B Superspeed Centrifuge. After 18 hours in the extractor, each sample was filtered through a nitex screen to eliminate coarse particles. The leachate sample was then passed through the KSB system by siphon from a reservoir bottle and slowly gravity fed through the centrifuge at a rate that would remove the greatest amount of fine particulates, yet would not require longer than a normal workday to prepare the leachate needed each day. The centrifuge was generally run at 12,000 to 14,000 rpm. This continuous flow centrifugation system is used in cell biology studies for concentrating live tissues, live cells, and cell particles. The system is completely constructed of stainless steel, except for gaskets which should

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not come in contact with much water. After each use, the system was completely dismantled and cleaned.

For the Daphnia test, twenty individuals less than 24 hours old were tested at each of five leachate concentrations (diluted with the control water), and a dilution water control. For each test, the twenty individuals were divided among two, 600 ml borosilicate beakers, each containing 500 ml of dilution water and/or leachate. Five to six dilutions of test water occurred each day by continuous flowing pumps from reservoirs containing test water and food. The food consisted of the green alga Ankistrodesmus falcatus, added to the test water at a concentration of 1.25 mg of carbon per liter. Deaths and accumulated reproduction were determined on each vessel on Monday, Wednesday, and Friday of each week. An analysis of variance or Kruskal-Wallis non-parametric test (if variances are non-homogeneous) was used to determine the effect of concentration of leachate which causes a significant difference from the control of these parameters. Dunnett's Many-t test, or the appropriate non-parametric analogue, was used to identify a no-effect concentration (NOEC), the lowest concentration that produced an effect (LOEC), and a maximum allowable toxicity concentration (MATC), calculated as the geometric mean of NOEC and LOEC estimates.

All fish used in the test were newborn, less than 48 hours old, hatched from eggs obtained from the state fish hatchery in Montgomery, Alabama. The Academy of Natural Sciences tried to begin the test with larvae hatched from eggs purchased from the Kurtz Fish Hatchery in Pennsylvania, but these developed fungus prior to the test and were discarded.

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The test chambers consisted of 500 ml beakers, with ten larvae in each beaker. Two replicate beakers were maintained for each test concentration. Animals were fed three times a day, initially with a protozoan mixture, and after three days with brine shrimp. At the beginning of the test, all living individuals from each test concentration, and the dilution water control (plus solvent control, if used) were measured at the end of the tests, the minnows were dried at 60°C for 24 hours, and weighed on a calibrated Mettler balance. The test concentrations used in the test were determined as a result of an initial screen test with larvae. An analysis of variance was used to compare weight increases relative to the control, as well as a Dunnett's Many-t test to determine NOEC, EC, and MATC, if variances proved to be homogeneous. Otherwise, non-parametric statistics were used.

Standard protocols (referenced above) were used for each test. Quality assurance/quality control procedures were followed. Only new or disposable glassware and chambers were used for these tests; all glassware was acid-washed, rinsed with acetone, washed with a laboratory non-detergent cleanser, and rinsed several times with distilled-deionized water prior to use.

#### 3.5.3.5 Additional Sediment Toxicity Bioassays

Additional floodplain sediment toxicity evaluations were requested by the reviewers of the Tyson's Site Off-Site Operable Unit Draft Remedial Investigation (RI) and Endangerment Assessment (EA) Report to complement the 21-day life cycle test using Daphnia and the fish larvae 7-day bioassays discussed above. The additional testing consisted of a liquid phase elutriate test

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with Daphnia and a short-term (2-day) solid phase sediment and beaker test which was subsequently extended to a 10-day Daphnia life cycle test. The methods presented below were derived primarily from conversations with Ms. Alyce Fritz, of NOAA, and from information provided by Ms. Fritz, specifically a copy of the following published article:

Nebeker, A. et al. 1984. Biologic Methods for Determining Toxicity of Contaminated Freshwater Sediments to Invertebrate. Environmental Toxicology and Chemistry, 3:617-630.

Additional input was provided by personal communication with Dr. Nebeker. All testing was conducted using juvenile Daphnia by Dr. Clyde E. Goulden, Division of Environmental Research, The Academy of Natural Sciences - Philadelphia, Pennsylvania.

#### Sediment Collection

The tests were run using surface sediment samples collected from the seven locations (Plate 8), described below:

<u>SITE</u>	<u>DESCRIPTION</u>
1	Ditch in Vicinity of Railroad Compressed Gas Tanks
2	Air Stripper Discharge Ditch
3	West Swamp/Pond
4	Ditch Near Signal Tower
5	Ditch Draining Western End of Site

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- 6 Ditch Approximately one-half mile  
West of Western Site Boundary  
(Control)
- 7 Area of Elevated DDT Levels Found  
During Previous Investigations

All samples were collected, prepared, preserved, and tracked (chain-of-custody) using the sampling and Quality Assurance Procedures detailed in the Off-Site RI Work Plan. All sampling equipment and sample containers were initially cleaned following a hot soapy water, tapwater, distilled water, pesticide grade acetone sequence. The cast aluminum trowel used in the field was cleaned using the same protocol between stations. Fifteen gallon carboys, cleaned as above, were used to collect dilution water at the Valley Forge Park boat launch area immediately upstream of the Betzwood Bridge (Route 363). The sediments were collected in food-grade permanently marked plastic buckets. Dilution water and sediments were delivered on the same day to the Academy of Sciences where the sediments were placed in a cold room prior to extraction. Sediments remaining after extraction were returned to the original collection sites.

Dilution water was collected from the Schuylkill River, upriver and out of any potential influence of the site in analytically precleaned 5 gallon carboys.

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### Chemical Analysis

A representative subsample of each sediment sample was submitted for the following analysis by Lancaster Laboratories, Lancaster, Pennsylvania:

Particle Size Distribution  
Percent Organic Matter  
Soil pH

Task 1 and Task 2 Metals  
Full HSL Organic Compounds  
1,2,3-Trichloropropane (TCP)

Samples of the dilution water and supernatant from the elutriate test, and the Daphnia life cycle test were also submitted for the metals, HSL, and TCP analyses.

### Toxicity Evaluation

The following bioassays were conducted following accepted protocols as presented in the USEPA Methods for Measuring Acute Toxicity of Effluents to Freshwater and Marine Organisms, modified to some degree because of the use of sediments instead

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of effluents. During each of the bioassays described below, the following parameters were measured daily:

Temperature  
Dissolved Oxygen  
pH  
Conductivity  
Alkalinity

All test chambers were gently aerated during the period of the test using glass tipped air lines. In addition to the control sediment, triplicate river dilution water controls were conducted. Test temperature were  $20 \pm 2^{\circ}\text{C}$ . All sediment bioassays were conducted in triplicate.

Three tests were conducted using the following two methods: (1) a liquid phase elutriate method which represents the worse case condition where the water and sediment are physically mixed for maximum release of sediment borne material, and (2) a solid phase sediment and water beaker method which represents field conditions where the water/sediment exchange is generally limited to the sediment surface. The second method was allowed to continue for 10 days and constitute a third test; a Daphnia life cycle test.

#### Liquid Phase Elutriate Test With Daphnia

Daphnia (<24 hours old) were exposed for 48 hours to centrifuged water samples obtained from a sediment-water slurry. The sediment was mixed with dilution water in a volumetric ratio of 1:4 (350 ml soil to 1400 ml of dilution water) and mixed

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vigorously for 30 minutes. The samples were allowed to settle overnight after which the supernatant was siphoned and centrifuged at 10,000 rpm for 15 minutes. The centrifuged water was transferred to three 250 ml beakers per sediment sample. Each beaker was gently aerated with a glass tipped air line approximately 1 cm below the water surface. After the dissolved oxygen levels measured above 75 percent saturation, ten Daphnia (<24 hours old) were placed in each of the three beakers and observed for survival in 48 hours.

Solid Phase Sediment and Water Beaker Test and Daphnia Life  
Cycle Test

This bioassay represents a combination of the two methods suggested by Dr. Nebeker during a telephone conversation on April 28, 1987. The method uses the sediment:water ratio of 500 ml of sediment to 2500 ml of dilution water in 4-liter widemouth jars and the organism loading rate from the life cycle test. The Daphnia are observed at 48 hours and the same test allowed to run for an additional 8 days for a total of 10 days exposure.

The dilution water was gently added with the contents of the beaker allowed to remain undisturbed for 3 days until any suspended sediment had substantially settled. After the three day settling period, a volume adjusted aliquot was collected for chemical analysis. The leachate was then gently aerated, algae food (Ankistrodesmus) added at 40,000 cells/ml, and the test organisms, 5 day old Daphnia, introduced. The survivors were counted after 48 hours. The animals were maintained (aerated and fed algae) for an additional 8 days (10 days total exposure)

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after which all survivors and progeny were captured on 120 um mesh and counted. The water in the beaker was then gently aerated by a glass tipped air line approximately 3 cm below the surface so as not to disturb the sediment. When the dissolved oxygen level exceeded 75 percent saturation, seven 5-day old Daphnia per liter of test solution were added and observed at both 48 hours and 10 days. It was agreed upon by Dr. Nebecker that a second set of sediment beaker extractions could be used as a replacement for the exposure water, if necessary. It was also agreed that survival chambers in the control sediment chambers as well as comparison of controls to the potentially impacted soils would be used to determine the validity of the tests.

### 3.6 Seep Area (Operable Unit 5)

Investigation of the Seep Area (Figure 3-6) was conducted to determine the nature and extent of any contamination which may exist in this area. For this investigation, 7 test pits were excavated and 16 soil samples were collected. Using a stainless steel trowel, depth discrete soil samples were homogenized in a stainless steel bowl and split with EPA's over-site contractor, NUS.

One duplicate and one laboratory matrix spike were collected during this investigation. Analytical parameters and detailed sample preparation, preservation, and storage procedures are outlined in Section 3.7.

The investigation of the Seep Area also included a review of historical aerial photos to determine past land usage in this

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area. Chemical analyses obtained during earlier investigations by EPA contractors were also procured.

### 3.7 Analytical Parameters and Sample Handling Procedures

Analytical parameters selected for various medias collected at the site and the number of samples analyzed, excluding duplicates, are shown on Table 3-5. The complete Hazardous Substance List (HSL) is presented on Table 3-6 and the analyses for this investigation included the volatile fraction plus 15 peaks, the base neutral plus fifteen peaks, and the acid extractable fraction plus 15 peaks. 1,2,3-trichloropropane is not an HSL organic compound but has been identified as a predominant organic chemical on site. As a tentatively identified compound, it would have been semi-qualitatively and semi-quantitatively identified in the additional peak analysis. To avoid this, a 1,2,3-trichloropropane standard was added to the HSL volatile organic fraction to provide qualitative and quantitative analyses.

Where appropriate, laboratory cleaned jars with teflon-lined lids were provided by Lancaster Laboratories of Lancaster, Pennsylvania. Following sampling, an adhesive label was affixed to each container, and checked for completeness before the samples were placed in insulated coolers when the samples were kept at about 4°C. Prior to overnight storage at the secure ERM warehouse, the samples were stored in a locked van or field office. Samples were relinquished by ERM to a Lancaster Laboratories' sample courier for transfer to the laboratory.

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TABLE 3-5

SUMMARY OF NUMBER OF SAMPLES AND  
TYPE OF ANALYSES CONDUCTED

Type of Analysis								
Sampling Area	Total Number Of Samples	HSL Inorganics	HSL Volatiles (+15)	HSL Semi-Volatiles (+20)	HSL Pesticides and PCBs	1,2,3- Trichloropropane	Total Organic Carbon	Grain Size
Seep Area (Test Pits - Soils)	16	X	X	X	X	X	-	-
Hillside (Soils)	9	X	X	X	X	X	-	-
Railroad (Borings - Sediments)	34	X	X	X	X	X	-	-
Floodplain (Sediments)	5	X	X	X	X	X	-	-
7/86	9	X(4)	X(4)	X(4)	X(4)	X(4)	X(9)	X(9)
3/87	7	X	X	X	X	X	X	X
5/87	1	X	X	X	X	X	-	-
6/87								
(Surface Water)	4	X	X	X	X	X	-	-
3/87	15	X	X	X	X	X	-	-
5/87	1	X	X	X	X	X	-	-
6/87								
River Bottom Sediments	14	-	X	X	-	X	-	-
10/86	6	-	-	-	-	-	X	X
4/87								

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TABLE 3-5 (cont'd)

SUMMARY OF NUMBER OF SAMPLES AND  
TYPE OF ANALYSES CONDUCTED

Sampling Area	Total Number Of Samples	Type of Analysis					Total Organic Carbon	Grain Size
		HSL Inorganics	HSL Volatiles (+15)	HSL Semi-Volatiles (+50)	HSL Pesticides and PCBs	1,2,3- Trichloroethane		
River Bottom Water	9	X(1)	X(9)	X(1)	X(1)	X(9)		
10/86	14	-	X	X	-	X		
2/87	9	-	X(9)	X(1)	X(1)	X(9)		
3/87	10	X(2)	X(10)	X(1)	X(1)	X(10)		
4/87	10	X(2)	X(10)	X(1)	X(1)	X(10)		
**4/87	2					X		
**River Water 6/87	12					X		
**Wells (ERM & NUS/EPA Wells	45	X(40)	X(45)	X(40)	X(40)	X(45)		
Well 55 during pump test	17	-	X	-	-	X		
Piezometers (Ground water)	7	-	X	-	-	X		

DNAPL 3 Two of these samples were analyzed for solvent screen, 1,2,3-trichloroethane, Brookfield Viscosity, and Specific Gravity. One sample was analyzed for Ignitability, Corrosivity and Reactivity.

\*\*Five NUS/EPA wells had insufficient water volume to collect a full sample aliquot.

\*\*Detection limit for these samples was parts per trillion as described in the Quality Assurance. X(2) indicates that the analysis was conducted for two of the samples.

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TABLE 3-6

SUMMARY OF HAZARDOUS SUBSTANCE LIST (HSL) PARAMETERS

VOLATILES	SEMI-VOLATILES (continued)
1. Chloromethane	41. 1,3-Dichlorobenzene
2. Bromomethane	42. 1,4-Dichlorobenzene
3. Vinyl Chloride	43. Benzyl Alcohol
4. Chloroethane	44. 1,2-Dichlorobenzene
5. Methylene Chloride	45. 2-Methylphenol
6. Acetone	46. bis(2-Chloroisopropyl) ether
7. Carbon Disulfide	47. 4-Methylphenol
8. 1,1-Dichloroethene	48. N-Nitroso-Dipropylamine
9. 1,1-Dichloroethane	49. Hexachloroethane
10. Trans-1,2-Dichloroethane	50. Nitrobenzene
11. Chloroform	51. Isophorone
12. 1,2-Dichloroethane	52. 2-Nitrophenol
13. 2-Butanone	53. 2,4-Dimethylphenol
14. 1,1,1-Trichloroethane	54. Benzoic Acid
15. Carbon Tetrachloride	55. bis(2-Chloroethoxy) methane
16. Vinyl Acetate	56. 2,4-Dichlorophenol
17. Bromodichloromethane	57. 1,2,4-Trichlorobenzene
18. 1,1,2,2-Tetrachloroethane	58. Naphthalene
19. 1,2-Dichloropropane	59. 4-Chloroaniline
20. trans-1,3-Dichloropropene	60. Hexachlorobutadiene
21. Trichloroethene	61. 4-Chloro-3-methylphenol (para-chloro-meta-cresol)
22. Dibromochloromethane	62. 2-Methylnaphthalene
23. 1,1,2-Trichloroethane	63. Hexachlorocyclopentadiene
24. Benzene	64. 2,4,6-Trichlorophenol
25. cis-1,3-Dichloropropene	65. 2,4,5-Trichlorophenol
26. 2-Chloroethyl Vinyl Ether	66. 2-Chloronaphthalene
27. Bromoform	67. 2-Nitroaniline
28. 2-Hexanone	68. Dimethyl Phthalate
29. 4-Methyl-2-pentanone	69. Acenaphthylene
30. Tetrachloroethene	70. 3-Nitroaniline
31. Toluene	71. Acenaphthene
32. Chlorobenzene	72. 2,4-Dinitrophenol
33. Ethyl Benzene	73. 4-Nitrophenol
34. Styrene	74. Dibenzofuran
35. Total Xylenes	75. 2,4-Dinitrotoluene
SEMI-VOLATILES	76. 2,6-Dinitrotoluene
36. N-Nitrosodimethylamine	77. Diethylphthalate
37. Phenol	78. 4-Chlorophenyl Phenyl ether
38. Aniline	79. Fluorene
39. bis(2-Chloroethyl) ether	80. 4-Nitroaniline
40. 2-Chlorophenol	

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TABLE 3-6 (cont'd)

SUMMARY OF HAZARDOUS SUBSTANCE LIST (HSL) PARAMETERS

SEMI-VOLATILES	PESTICIDES (continued)
81. 4,6-Dinitro-2-methylphenol	121. Methoxychlor
82. N-nitrosodiphenolamine	122. Chlordane
83. 4-Bromophenyl Phenyl ether	123. Toxaphene
84. Hexachlorobenzene	124. AROCLOR-1016
85. Pentachlorophenol	125. AROCLOR-1221
86. Phenanthrene	126. AROCLOR-1232
87. Anthracene	127. AROCLOR-1242
88. Di-n-butylphthalate	128. AROCLOR-1248
89. Fluoranthene	129. AROCLOR-1254
90. Benzidine	130. AROCLOR-1260
91. Pyrene	
	INORGANICS
92. Butyl Benzyl Phthalate	131. Aluminum
93. 3,3'-Dichlorobenzidine	132. Antimony
94. Benzo(a)anthracene	133. Arsenic
95. bis(2-ethylhexyl) phthalate	134. Barium
96. Chrysene	135. Beryllium
97. Di-n-octyl Phthalate	136. Cadmium
98. Benzo(b)fluoranthene	137. Calcium
99. Benzo(k)fluoranthene	138. Chromium
100. benzo(a)pyrene	139. Cobalt
101. Indeno(1,2,3-cd)pyrene	140. Copper
102. Dibenzo(a,h)anthracene	141. Iron
103. Benzo(g,h,i)perylene	142. Lead
PESTICIDES	143. Manganese
104. alpha-BHC	144. Mercury
105. beta-BHC	145. Nickel
106. delta-BHC	146. Selenium
107. gamma-BHC (Lindane)	147. Silver
108. Heptachlor	148. Thallium
109. Aldrin	149. Tin
110. Heptachlor Epoxide	150. Vanadium
111. Endosulfan I	151. Zinc.
112. Dieldrin	
113. 4,4'-DDE	
114. Endrin	
115. Endosulfan II	
116. 4,4'-DDD	
117. Endrin Aldehyde	
118. Endosulfan Sulfate	
119. 4,4'-DDT	
120. Endrin Ketone	

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Floodplain and river water samples collected in June 1987 were placed directly into containers provided by CompuChem Laboratories of Chapel Hill, North Carolina. Following sampling, the samples were packed in cartons with ice packs and secured with custody seals before shipment via Federal Express to CompuChem Laboratories. Additional information for quality control, quality assurance and chain of custody procedures are included in the Quality Assurance Project Plan (QAPP) which is an attachment to the Off-Site Operable Unit RI Work Plan.

Stainless steel spoons, trowels, bowls, steel split spoons, and aluminum core barrels were used during the collection and compositing of soil and sediment samples. All utensils were decontaminated using an alconox and acetone wash followed by a distilled water rinse, initially and between samples. Utensils used for the collection of 1987 floodplain soils were decontaminated using an Alconox and water wash, water rinse, methanol rinse, followed by water and distilled water rinses. Stainless steel bailers used during ground water sampling were cleaned by steam cleaning, acetone wash and distilled water rinse. The Kemmerer sampler used for collecting surface water samples was washed with Alconox and rinsed with distilled water.

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## SECTION 4

### RESULTS OF THE FIELD INVESTIGATION

#### 4.1 Site Geology

##### 4.1.1 Introduction

Three types of geologic materials were encountered during the investigation: the overburden materials south of the railroad tracks, the floodplain deposits north of the railroad tracks, and the Lower Member of the Stockton Formation which underlies all of the unconsolidated materials within the area of the investigation. Except where noted, much of the information presented in the following subsections was derived from the field reconnaissance, fracture trace analysis, installation of 33 bedrock monitoring wells, the completion of 10 soil borings along the railroad tracks, and excavation of test pits in the seep area.

##### 4.1.2 Overburden Materials South of the Railroad Tracks

Overall, the topography of the area south of the railroad tracks can be described as two terraces with two intervening steep slope sections. The lower terrace, closest to the tracks has been disturbed by previous site activities. Although the Off-Site Operable Unit RI focused primarily on the areas north of the former lagoons, an understanding of the relationship between overburden materials in the area of the lagoons and the underlying bedrock aquifer is critical to understanding pathways

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for contaminant migration. Information presented in this section is derived from the previous investigations and this RI. The results of the previous investigations are reported in the following documents:

- "Remedial Investigation Report and Feasibility Study Work Plan for Tyson's Dump Site, Montgomery County, Pennsylvania", Baker/TSA, August 1984,
- "Supplemental Site Assessment Tyson's Dump Superfund Site, King of Prussia, Pennsylvania", conducted by Woodward-Clyde Consultants (August, 1985), and
- SRW Associates, Inc. Report of Additional Subsurface Exploration and Analysis, (November, 1985).

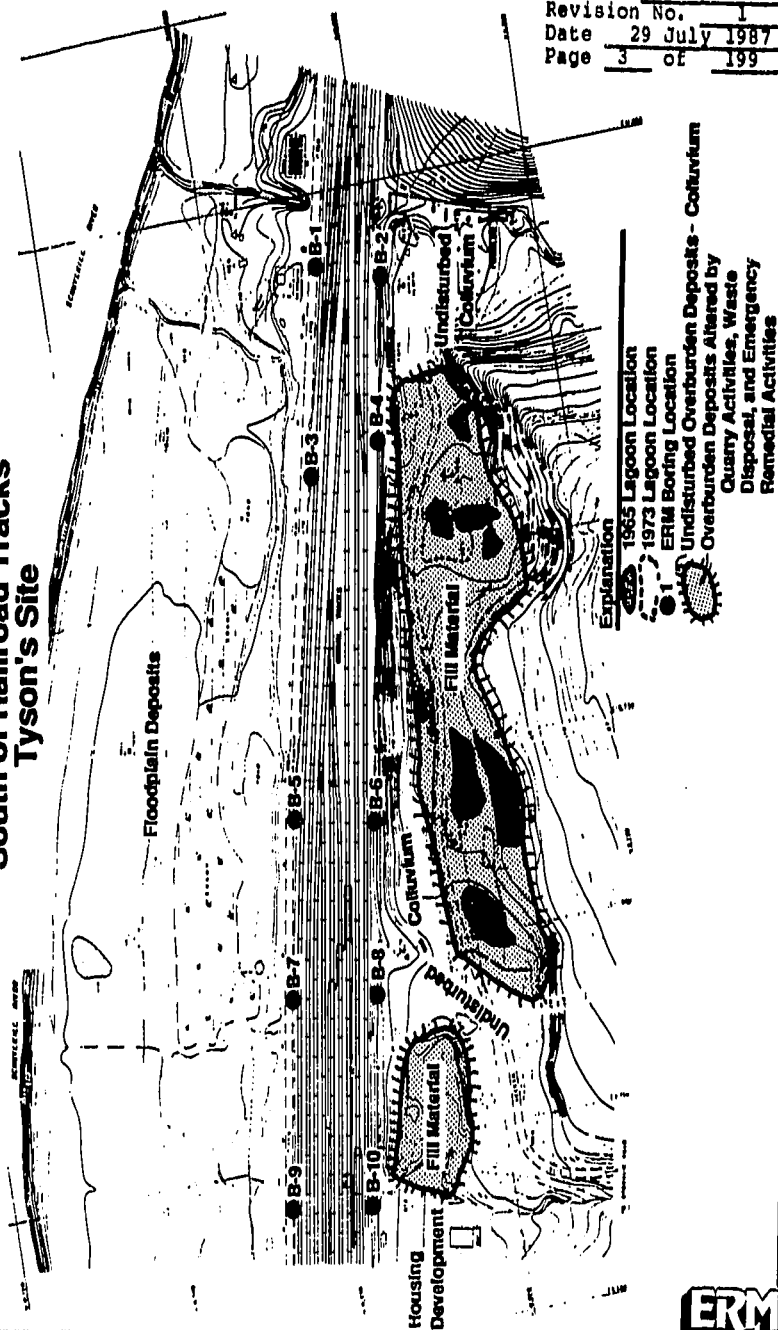
The overburden materials south of the railroad tracks can be divided into three types of materials: undisturbed colluvial deposits, fill material implaced during past remedial activities at the former lagoon areas, and construction debris and fill material in the seep area. Figure 4-1 shows the approximate distribution of the various overburden materials. Plates 9 and 10 are a top of bedrock contour map and a cross-section through the former lagoon area, respectively. These plates were taken as is from the Woodward-Clyde Consultants, Inc. report, "Supplemental Site Assessment, Tyson's Dump Site, King of Prussia, Pennsylvania".

The undisturbed overburden deposits generally consist of a thin topsoil overlying the colluvial deposits and weathered bedrock.

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**Figure 4-1  
Distribution of Overburden Deposits  
South of Railroad Tracks  
Tyson's Site**



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The topsoil is a organic rich silty sand. The colluvial materials and weathered bedrock are comprised of sandy silts with some clays. Some fine to coarse gravel is also found at depth in the unconsolidated deposits. The thickness of the colluvial material varies greatly over the area, from thirty-one and one half feet at the eastern border of the site (Boring B-2 completed by ERM) to absent where bedrock outcrops between the eastern and western sets of lagoons. The logs for these borings are included in Appendix E.

The former lagoon area can best be described as two bowl-like depressions in the bedrock surface separated by a bedrock high (Plate 10). The western set of lagoons is divided into two depressions separated by a second bedrock high. The thickness of the fill material within these depressions varies from a maximum of twenty-five feet to absent at the bedrock highs. Plate 10 (Woodward and Clyde Cross Section) depicts these features, however the existence of bedrock outcrops was not shown. The overburden materials within the former lagoon area are primarily intermixed fill materials of silty, gravelly sand, quarry rubble, possible residual sludges, construction debris, and colluvium. These materials were emplaced during the past disposal and remedial activities at the site. Topsoil in these areas is thin and often discontinuous.

Seven test pits were installed south of the railroad tracks in the seep area during the RI. Locations of these test pits are shown on Plate 7. The logs for these test pits are included in Appendix F. The overburden materials encountered during installation of the test pits includes a mixture of disturbed and undisturbed colluvial deposits and construction debris. The

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construction debris is comprised of cinder blocks, wood, glass, and plastic materials.

The greatest thickness of fill material in the seep area is about six feet. As mapped in the test pits, undisturbed colluvial deposits underlie the fill material to a depth greater than eleven feet (the maximum depth of the test pits). Bedrock was not encountered in any of the test pits.

#### 4.1.3 Floodplain Deposits

The Schuylkill River floodplain begins at the base of the bedrock outcrop just north of the former lagoon area, essentially parallel to and immediately south of the Conrail tracks (Figure 4-1). With the exception of the ravine east of the lagoons, the thickness of the floodplain deposits beneath the railroad tracks varies from three to ten feet. The thickness of these deposits at Boring B-2 (Figure 4-1) in the ravine near the eastern edge of the site was 31.5 feet, nearly three times that of any other boring completed south of the Conrail tracks. Similar findings were reported for the previous investigation conducted by Woodward-Clyde Consultants (25.3 feet at Boring B-28, Plate 7). The unusually thick deposits are the result of a zone of increased bedrock weathering resulting from a zone of fracture concentration in the bedrock. As discussed in Subsection 4.1.4, the large ravine adjacent to these two borings is also a result of the enhanced weathering.

As shown on Figure 4-2, depth to bedrock beneath the railroad tracks drops sharply from three to ten feet at the base of the

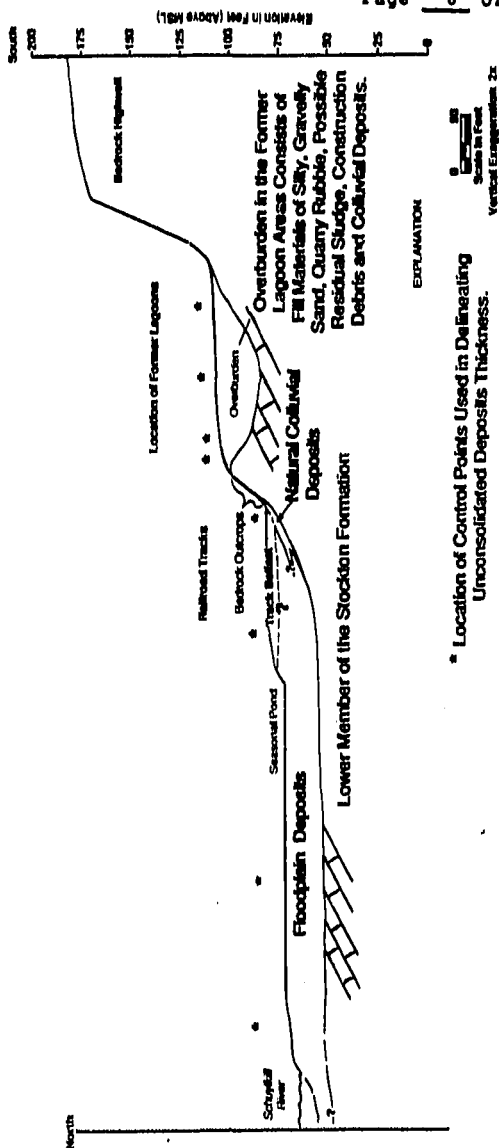
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**Figure 4-2**  
**North-South Cross Section**  
**Unconsolidated Deposits**  
**Tyson's Site**



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embankment south of the railroad tracks to greater than twenty feet on the north side of the railroad tracks.

The railroad tracks are supported by a ballast which ranges between 1.5 and 9.4 feet in thickness. The ballast consists of very coarse crushed stone (limestone) with a dark very fine grained cinder matrix. Floodplain deposits underlying the ballast are comprised of interbedded silty, sandy clay, white coarse gravel, and gravel-sized clasts of weathered arkosic sandstone. It appears that materials in this area actually represent a transition between the colluvial deposits originating from the steep hillside and the floodplain deposits. The floodplain deposits north of the railroad tracks can be divided into three sub-units as follows:

- The upper one to two feet of organic rich silty clay.
- Ten to fifteen feet of brownish red sandy clays, sometimes mottled with some silt, trace gravel and cobbles. (This material becomes coarser toward the north, approaching the river. Some boulders encountered at Well Nest 8, adjacent to the river.)
- A basal sand and gravel unit with some cobbles which lies on top of bedrock. This unit is approximately ten feet thick at the river, but pinches out to the south until it is absent at the railroad tracks.

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#### 4.1.4 Fracture Trace Analysis

Five major fracture traces were identified within the vicinity of the site. Although floodplain deposits can mask features useful in delineating fractures, the traces shown on Figure 4-3 are drawn with a high degree of confidence as they manifest themselves on multiple sets of aerial photographs. The fracture traces have been labeled A through E.

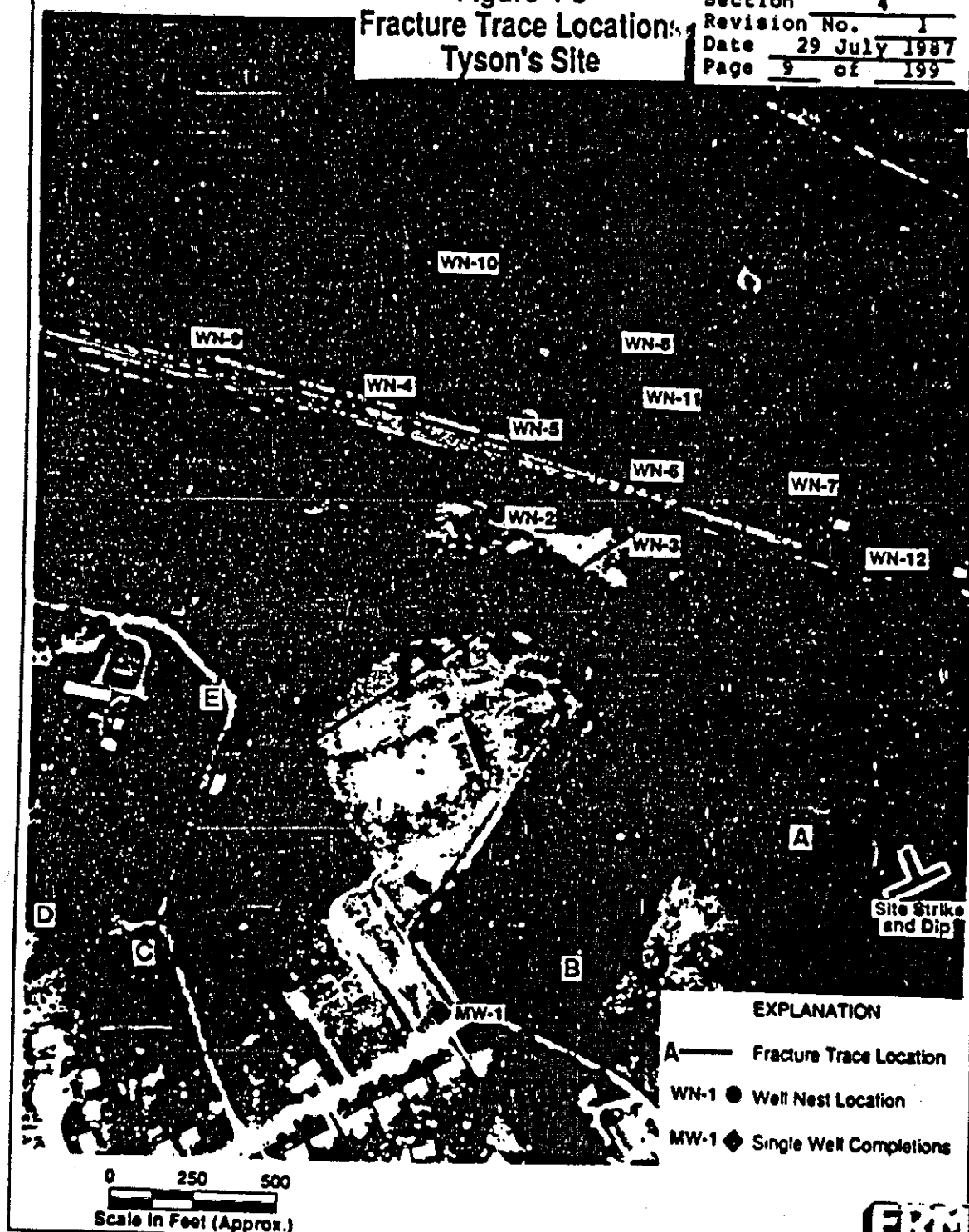
Fracture traces A and B intersect near the deep ravine to the east of the former lagoon area. Fracture trace A is nearly perpendicular to the strike of bedrock. Fracture traces B and C are parallel and oriented north-northeast at a low angle to the direction of strike. Fracture trace C passes to the west of the former lagoon area. The surface expression of this trace includes a small ravine west of the security fence to a small spring at the base of the bedrock outcrop adjacent to the railroad tracks. This location is further noted by a depression in the underlying bedrock surface as indicated by soil borings completed in the area. Fracture trace D is oriented northeast and passes through the eastern set of lagoons. It is expressed as an increase in the frequency of jointing as measured on the quarry high wall south of the lagoons and as an increased depth to bedrock at Well 3-S. Depth to bedrock at well 3-S is 20-feet, however, not more than 30-feet to the west of well 3-S, the measured depths to bedrock at wells 3-I and 3-D were 4.5 and 7.5 feet, respectively. This rapid lateral variation in the thickness of the overburden materials along fracture trace D is also shown on Plate 9. Increased weathering in this zone of fracture concentration was likely to be a major factor influencing the location of the eastern lagoons. The depth of

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**Figure 4-3**  
**Fracture Trace Location**  
**Tyson's Site**

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weathering allowed excavation of the depression forming the lagoons. Fracture trace E is oriented nearly north-south and is manifested in the small ravine west of the site.

#### 4.1.5 Lower Member of the Stockton Formation

##### 4.1.5.1 Field Measurements

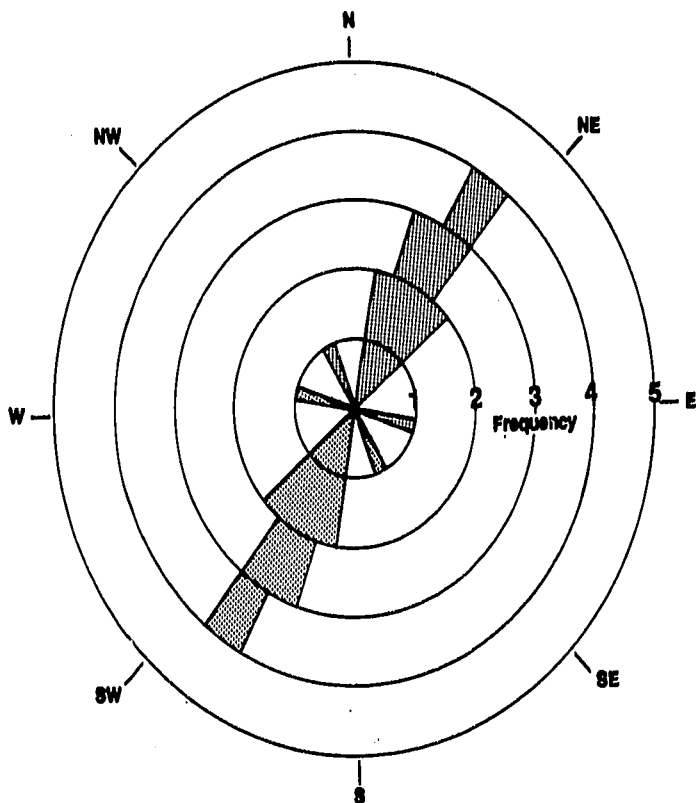
Field reconnaissance conducted for the RI included structural measurements on exposures of the Lower Member of the Stockton Formation in the lagoon area and quarry high wall. Multiple strike and dip measurements were taken to ensure the representativeness of the values. Caution was given to take these readings only where materials appeared to be in place and not affected by slumping. An average strike of N 67° E was calculated from eight representative measurements. The dips of the bedding planes ranged from 9° to 24° N with a mean of 16° N. The average strike and dip values agree with those derived by Rima, et. al. (1962).

Joint sets, nearly perpendicular to bedding were observed in the outcrops. Thirteen joint orientations were measured at ten locations. These have been plotted on a rose diagram (Figure 4-4). As indicated by eleven of the thirteen measurements, one or more joint sets are predominant between N 10° E and N 50° E. Four of the measured values were between N 30° E and N 40° E.

The frequency of jointing was also measured at seven locations on the quarry highwall (south of the lagoons). The average joint frequency was found to be 8.5 joints per 10 feet, with a range of 9 to 22. At one location, where the projection of fracture trace

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**Figure 4-4**  
**Rose Diagram - Joint Orientations**  
**Tyson's Site**



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D intersected the quarry highwall, the measured joint frequency was observed to be 20 joints per 10 feet, at the high end of the range.

#### 4.1.5.2 Well Boring Data

The lithology of the Lower Member of the Stockton Formation, as encountered during the installation of the thirty-three bedrock monitoring wells, is shown on the cross-sections Plates 11 through 14 (Figure 4-5). Geologic logs for the bedrock wells are given in Appendix G. Cross-sections A and B are drawn from the south, through the western and eastern set of lagoons, respectively, to the north. Cross-sections C and D are drawn west to east along the floodplain parallel to the Schuylkill River.

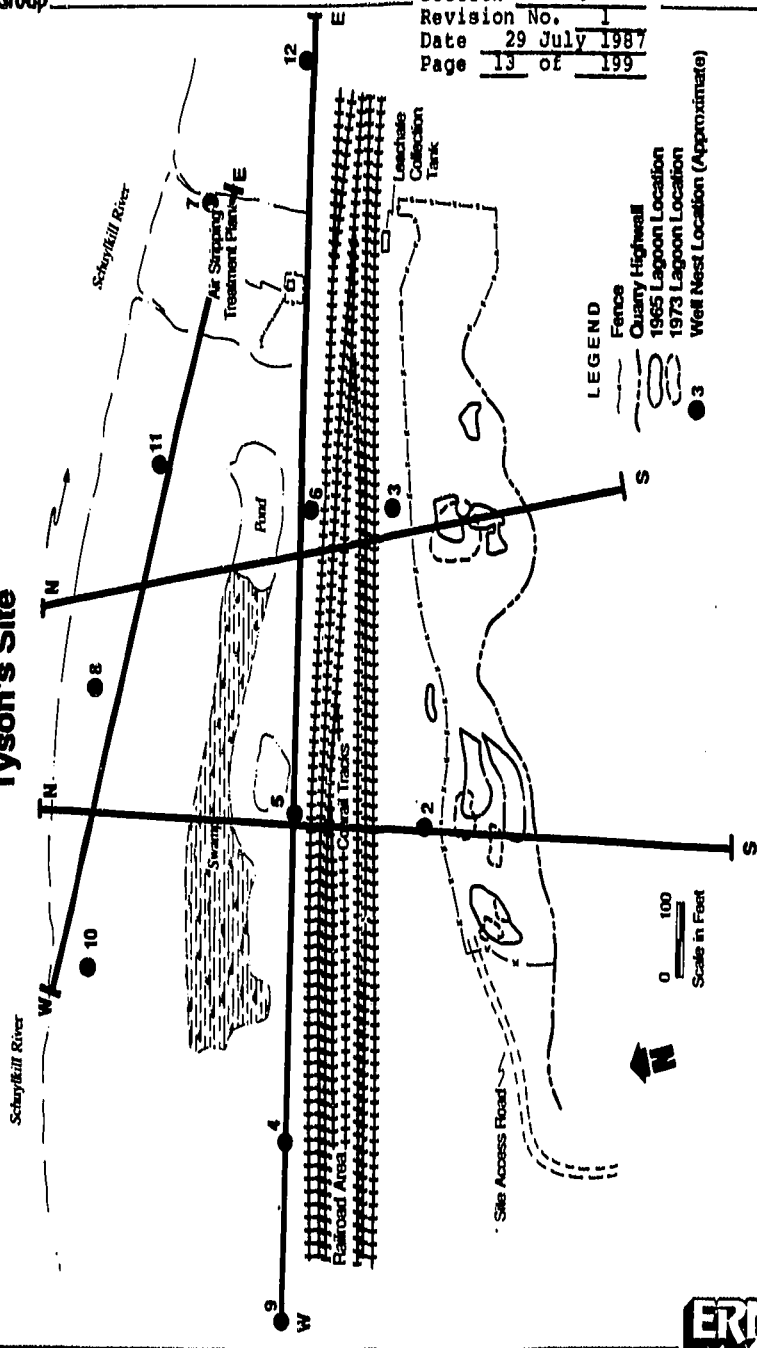
The Lower Member of the Stockton Formation beneath the site can be divided into four lithologic units, each of which is highly variable in thickness. These units, from shallowest to deepest, include:

- Brownish-Red Arkosic Sandstone, dark to light brownish-red, medium to coarse grained, arkosic sandstone, with trace biotite and quartz cobbles; the average thickness is twenty feet.
- Light Grey Green Arkosic Sandstone, light grey-green arkosic sandstone with some dark green fine to medium grained arkosic sandstone, with trace to little biotite and trace olive green medium grained arkosic sandstone; the average thickness is seventy-five feet.

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**Figure 4-5**  
**Cross Section Locations**  
**Tyson's Site**





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- Red Shale, dark red silty shale with a trace biotite, typically five to ten feet thick.
- Dark Green Arkosic Sandstone, dark green fine to medium grained arkosic-subarkosic sandstone, trace biotite, little to some light grey green medium to coarse grained sandstone, trace biotite. This basal unit was found to be at least forty feet thick.

In general, as shown on the geologic cross-sections, the light grey-green and dark grey-green arkosic sandstones are the predominant lithologies. These units and the dark red-brown arkosic sandstone drilled firm and hard, indicative of a competent unweathered sandstone. However, intermittent soft zones of a foot or less were frequently encountered in these units while drilling. The soft zones generally decreased in number with depth and were least abundant in the lowermost dark green arkosic sandstone. These thin, soft zones represent intervals of increased fracturing, thin interbedded shales, or weathered bedding planes. At Well Nests 7, 11, and 12, there was a marked increase in the occurrence of interbedded red siltstone and shale.

The red shale unit was encountered in the transitional zone between the two green sandstone units at Well Nests 3, 6, 8, and 11. Drilling rates through this unit was much faster than that of the sandstones. This red shale was encountered at 80 to 125 feet below the surface. In addition, the shale cuttings often appeared weathered.

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## 4.2 Site Hydrogeology

The site hydrostratigraphy, water level data, direction of ground water flow, aquifer testing, and behavior of DNAPL are addressed in the following discussion. The site's hydrostratigraphy has been defined through the use of drill log information obtained during the installation of monitoring wells. Vertical and horizontal hydrostatic head relationships have been determined through a series of water level measurements taken throughout the course of the investigation. The values for parameters that characterize the bedrock aquifer underlying the site were obtained through various types of aquifer testing, including: slug tests, step drawdown tests (well recovery), constant rate tests, and a 7-day (long-term) pump test. Various testing conducted to determine the occurrence of DNAPL in the bedrock aquifer is presented at the end of this section. Discussion concerning the occurrence and behavior of DNAPL in the bedrock aquifer is provided in this latter discussion.

### 4.2.1 Site Hydrostratigraphy

Hydrostratigraphic units present at the site include the unconsolidated deposits and the underlying arkosic sandstone aquifer (Lower Member, Stockton Formation). The site hydrostratigraphy is illustrated on Plate 15.

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#### 4.2.1.1 Unconsolidated Deposits

The unconsolidated materials that overlie bedrock south of the railroad tracks, are discussed in Section 4-1. These materials are separated from the railroad ballast and floodplain deposits to the north by a significant portion of bedrock (Figures 4-1 and 4-2).

South of the railroad tracks, unconsolidated materials surround and underlie the former lagoons between several bedrock highs (outcrops). In the course of the Off-Site Operable Unit RI, depth to water measurements have shown that some of the EPA's monitoring wells completed in these materials were dry for at least some portion of the investigation. It is believed that the occurrence of the water found in these materials is actually "perched water" which is ponded on low permeability tar-like materials left on the bottom of the former lagoons after closure. This water is not perennial, but when present it slowly percolates into the fractured bedrock beneath the lagoons. The temporarily perched ground water would not be capable of yielding any significant amount of water on a sustained basis to wells or springs. Therefore, by EPA definition, these materials cannot be considered an aquifer.

As shown in Figures 4-1 and 4-2, the floodplain deposits extend from the railroad tracks north to the Schuylkill River. These deposits consist of up to 25 feet of unconsolidated materials described in Section 4.1.3.

The occurrence of ground water in the floodplain deposits is attributed to a zone of enhanced permeability provided by the

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layer of sands and gravels at the base of the floodplain deposits. The ground water in the floodplain deposits is recharged by infiltration of surface runoff and ground water recharge from the bedrock aquifer.

Surface runoff from the south enters a series of ponds located on the floodplain deposits north of the railroad tracks. These ponds are considered to be "seasonal" because they were dry during a period of minimal precipitation between mid-June and late July, 1986. The occurrence of the ponds is due to the low permeability of the silts and clays in the upper portion of the floodplain deposits and seasonally high precipitation. It is believed that the ground water in the floodplain deposits receives recharge as vertical leakage from the ponds, and that water originating from these ponds also drains to the Schuylkill River through intermittent streams.

#### 4.2.1.2 Bedrock Aquifer

The bedrock aquifer at the Tyson's Site is the Lower Member of the Stockton Formation. The regional occurrence of ground water in the Lower Member is described in Section 2.2. Recharge to the bedrock aquifer occurs in the areas south of the site where the Lower Member is exposed or close to the surface. During the course of monitoring well installation, an attempt was made to complete wells in three separate zones in the bedrock aquifer. These zones are referred to as the shallow, intermediate, and deep zones. The rationale for monitoring a specific interval at a specific well location was based primarily on local stratigraphic correlations within the Lower Member and, secondly, on the relative depth of other monitoring wells installed at the

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site. Shallow zone wells were installed approximately 30 to 100 feet below ground surface in the brownish red arkosic sandstone that occurs near the surface. The intermediate monitoring wells were installed 75 to 163 feet below the land surface and were generally completed in the light grey-green arkosic sandstone. The intermediate wells on occasion were also installed within the thin red shale which marked the transition zone between the dominating green sandstone. Deep zone monitoring wells were installed 115 to 223 feet below the surface. Lithologic description of the deep zone varied from a dark green to light green arkosic sandstone.

Both primary and secondary permeability are apparent in all three zones monitored in the bedrock aquifer. Primary permeability is contributed from the intergranular space between grains of material comprising the matrix of the bedrock. Primary permeability is variable depending on the competency of the matrix between the coarser grains. The matrix experiences variable degrees of weathering observed at the site outcrops and in cores obtained during previous investigations. Highly weathered portions of the aquifer provide greater primary permeability due to the decomposition and removal of the matrix. In less weathered intervals, the argillaceous matrix fills the space between coarse grained material, thus reducing permeability.

Secondary permeability is contributed by discontinuities such as joints, fractures, faults, and weathered bedding planes. The occurrence of significant zones of enhanced secondary permeability is represented by the fracture traces shown on Figure 4-3. The fracture traces are indicative of vertical

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planes of fracture concentration. These planes act as conduits for ground water flow and represent preferred paths for the migration of contaminants in ground water.

Step drawdown tests were conducted to obtain sustainable yields for select monitoring wells in the monitoring network. The results of these tests are provided in Section 4.2.3.2 and indicate that the well yield decreases significantly with depth. The highest yields were obtained from the shallow zone wells whereas the intermediate and deep zone wells produced significantly less water. The decrease in permeability with depth is related to a combination of factors, including reduced weathering and the closing of fractures.

#### 4.2.2 Direction of Ground Water Flow

##### 4.2.2.1 Water Level Data Acquisition

Water elevations have been measured for the complete monitoring well network from March 1986 to July 1987. Using these data, the occurrence of ground water on site, including seasonal variations in water levels, and both the horizontal and vertical components of ground water flow can be described. Water level elevation data are provided in Appendix H.

As previously described, water level elevations have been collected throughout the course of this remedial investigation. However, emphasis will be placed on data obtained after April 1987 as these measurements represent a time period in which the water levels in all wells had equilibrated following pump testing and ground water sampling efforts completed in May 1986. This is

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of particular importance given the very slow recovery of water levels in many of the site's deep wells following any pumping. In addition, to accurately measure water levels in the site's artesian wells, special apparatus (described in Section 3.2.2) had to be installed and water levels allowed to equilibrate.

#### 4.2.2.2 Horizontal Direction of Ground Water Flow

The ground water configuration in the shallow unconsolidated deposits of the on-site and floodplain areas is shown in Figure 4-6. In general, the shallow ground water configuration is a subdued reflection of the surface topography with ground water flowing north towards the Schuylkill River. On-site the water table contours mimic the surface of the quarry floor. A depression occurs in the eastern lagoon area where the fill materials are being drained by the underlying fractured bedrock. Steep hydraulic gradients occur south of the tracks in the near surface bedrock while gentler hydraulic gradients occur north of the tracks in the floodplain.

Piezometric surface maps, illustrated in Figures 4-7 to 4-9, reflect ground water conditions of April 17, 1987 in the shallow intermediate and deep zones of the bedrock aquifers. Within the shallow zone, the piezometric surface exhibits a reflection of the surface topography with a gentle mounding in the center of the site. Flow is north towards the river with hydraulic gradient ranging from 0.035 to 0.047 (dimensionless).

The intermediate piezometric surface map is characterized by an elongated mound oriented northeast in the center of the site. This mound extends from the on-site area to the Schuylkill River.

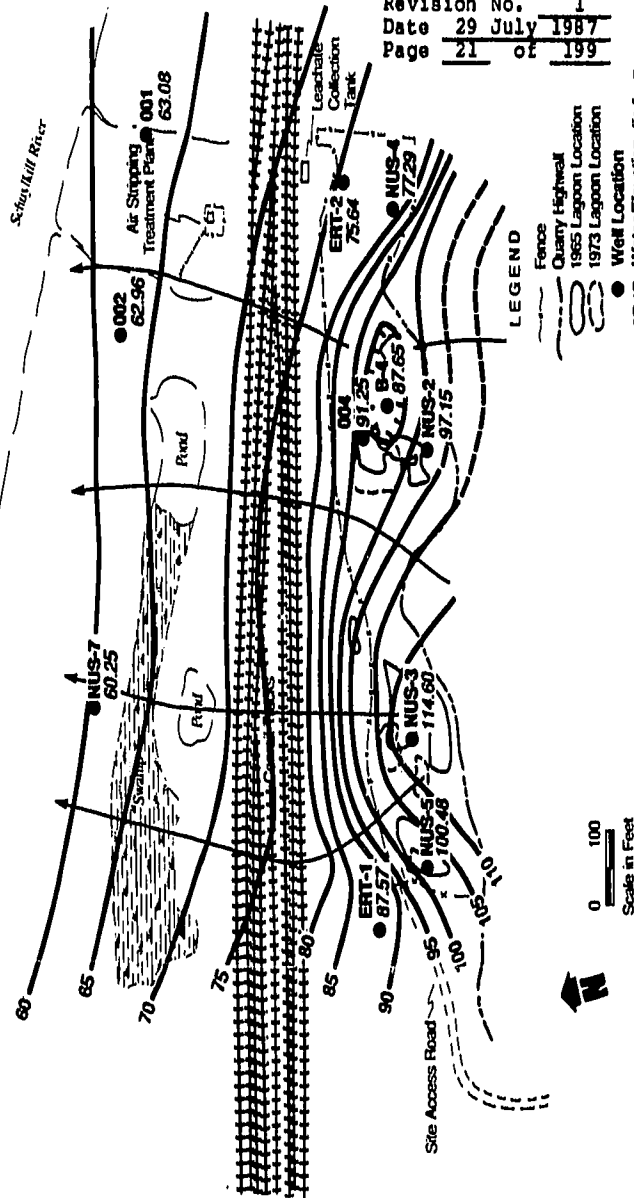
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**Figure 4-6**  
**Water Table Map**  
**in Unconsolidated Deposits**  
**Tyson's Site**

Schoykill River  
Elevation  
59.30



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LEGEND

- Fence
- Quarry Highway
- 1965 Lagoon Location
- 1973 Lagoon Location
- Well Location
- Water Elevation (in feet)
- Ground Water Flow Direction

Note: All Water Levels are as of 27 April 1987.

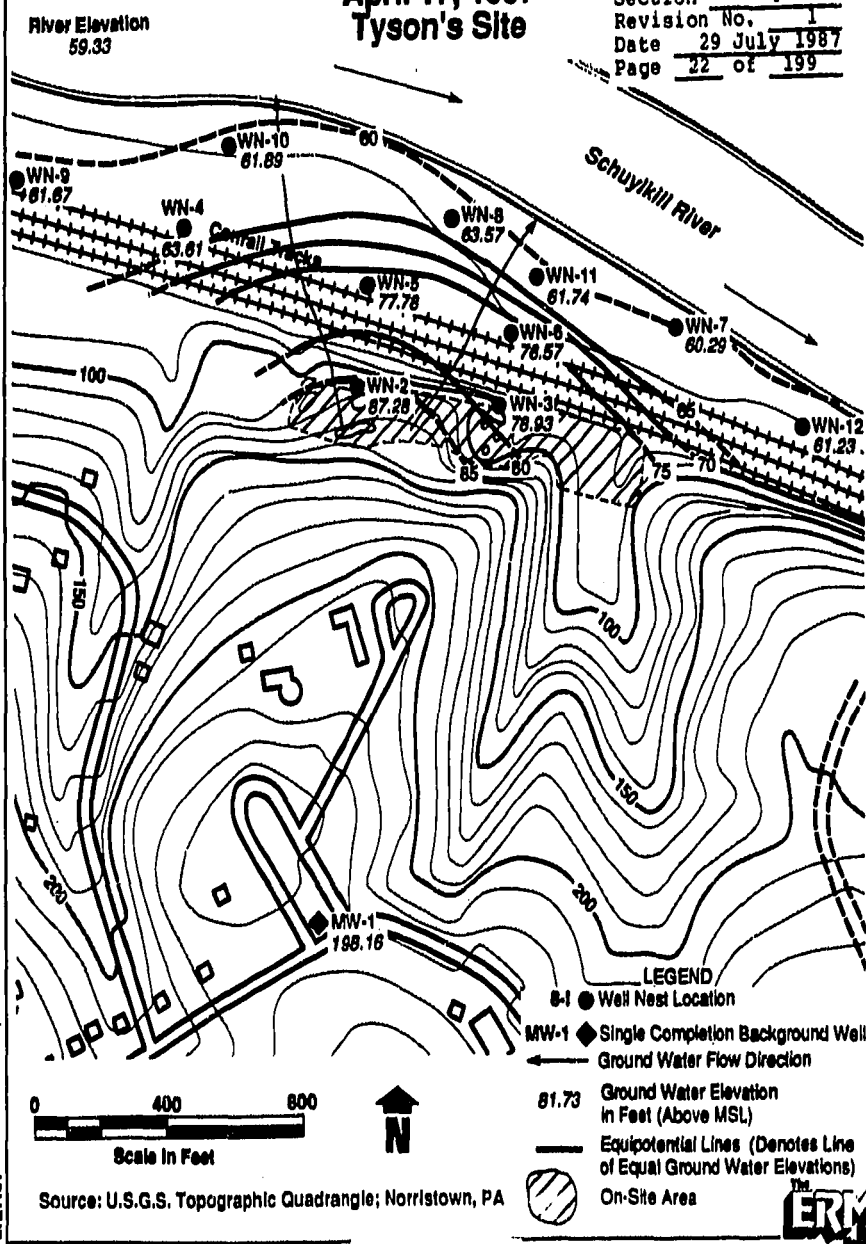
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# **Figure 4-7** **Piezometric Surface - Shallow Wells** **April 17, 1987** **Tyson's Site**

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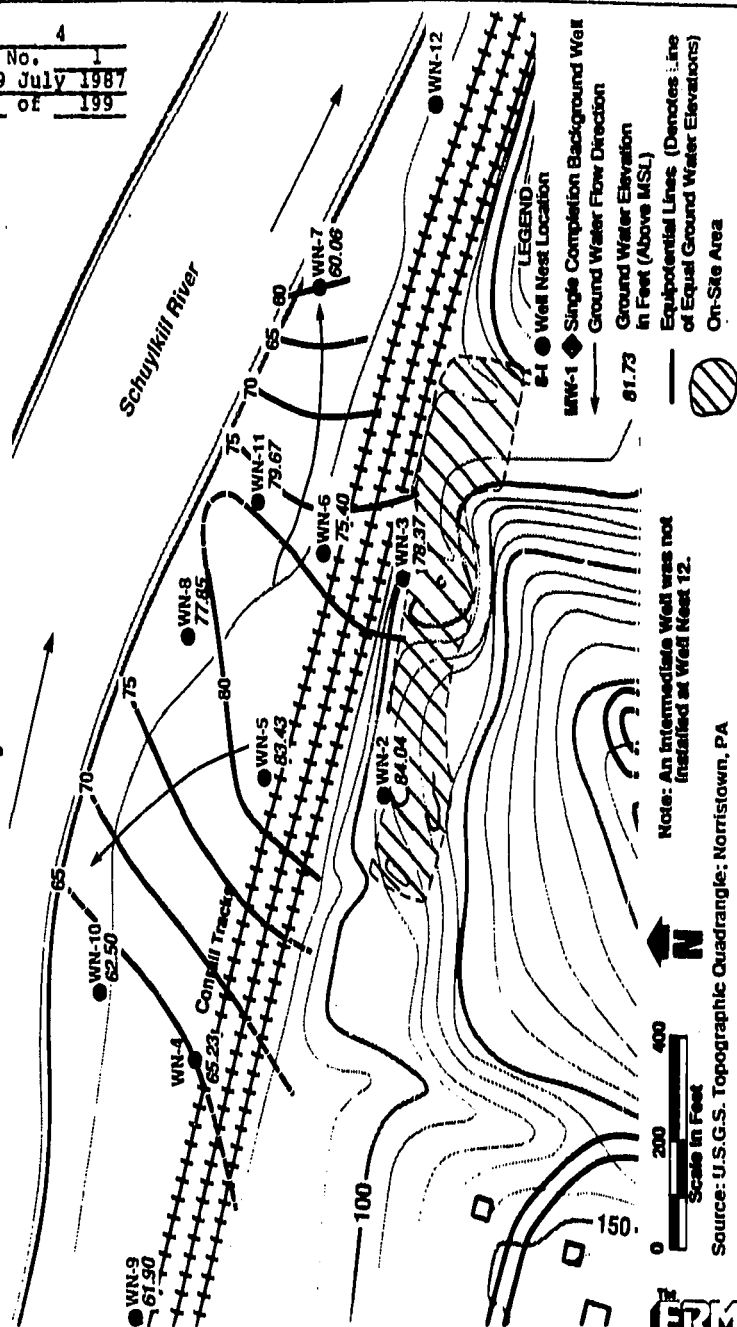


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**Figure 4-8**  
**Piezometric Surface - Intermediate Wells**  
**April 17, 1987**  
**Tyson's Site**

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River Elevation  
 59.33



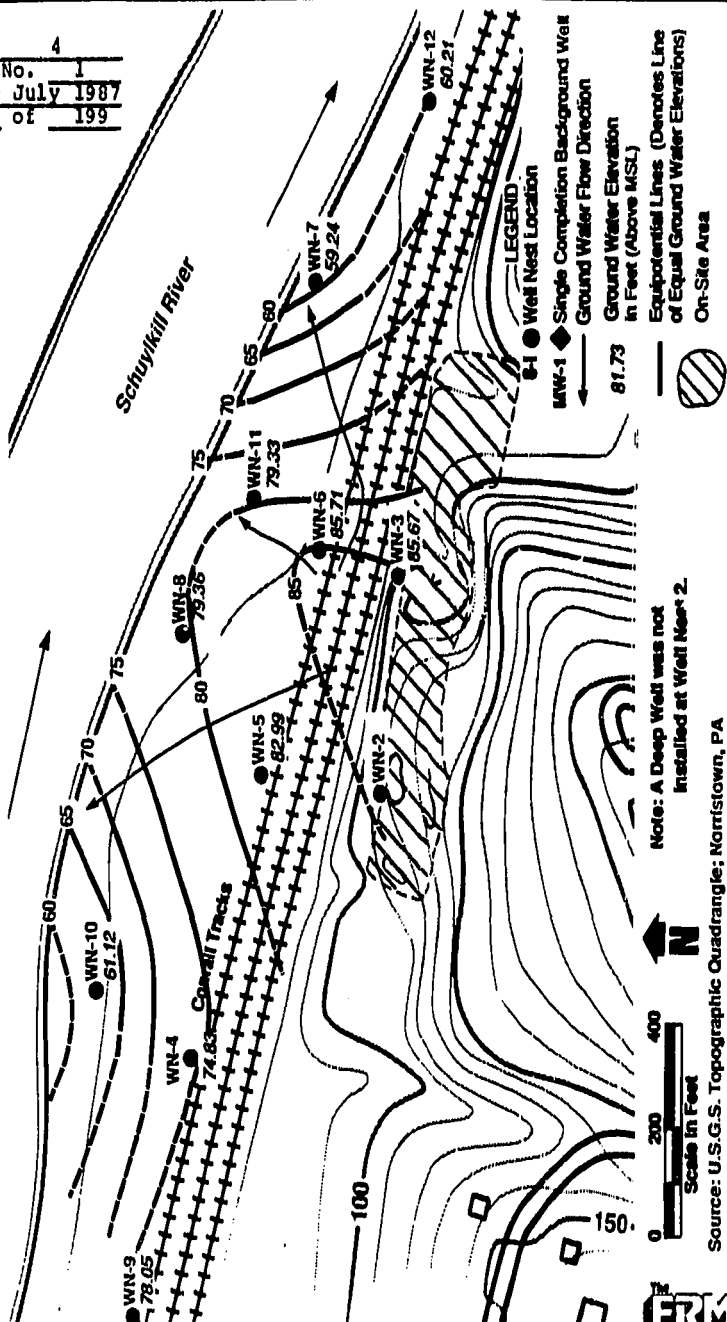
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# **Figure 4-9** **Piezometric Surface - Deep Wells** **April 17, 1987** **Tyson's Site**

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River Elevation  
59.33



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Ground water flow along the flanks of the mound is radial toward the river with hydraulic gradients ranging from 0.035 to 0.04 (dimensionless).

Although less defined, ground water mounding in the center of the site is evident within the deep aquifer and the direction of ground water flow is similar to the intermediate zone, towards the Schuylkill River. Hydraulic gradients are somewhat greater than the intermediate, ranging from 0.35 to 0.05 (dimensionless).

#### 4.2.2.3 Vertical Components of Ground Water Flow

Vertical components of ground water flow are illustrated on Plate 13. In general, the water level elevations indicate an upward flow gradient in the bedrock aquifer. This upward gradient represents the discharge of a regional ground water flow system to the Schuylkill River.

As shown on Plate 13, at well nest 8, the hydrostatic level at Well Nest 8 for the intermediate well is 13.87 feet higher than the level measurement in the shallow well. In turn, the deep zone level is 2.91 feet higher than the intermediate zone level. This relationship of increasing hydrostatic level with increasing depth was also observed at well nests 3, 4, 5, 6, 8, 9, 10 and 11. As a typical example, the upward flow gradient is illustrated in the hydrographs for well nest 5 (Figure 4-10). Occasionally, slight reversals in the upward vertical gradient were also observed at these well nests. At these times the hydrostatic level for the deep zone wells was slightly lower than the intermediate zone level. However, the measured levels for the shallow zone wells were always lower in elevation than the

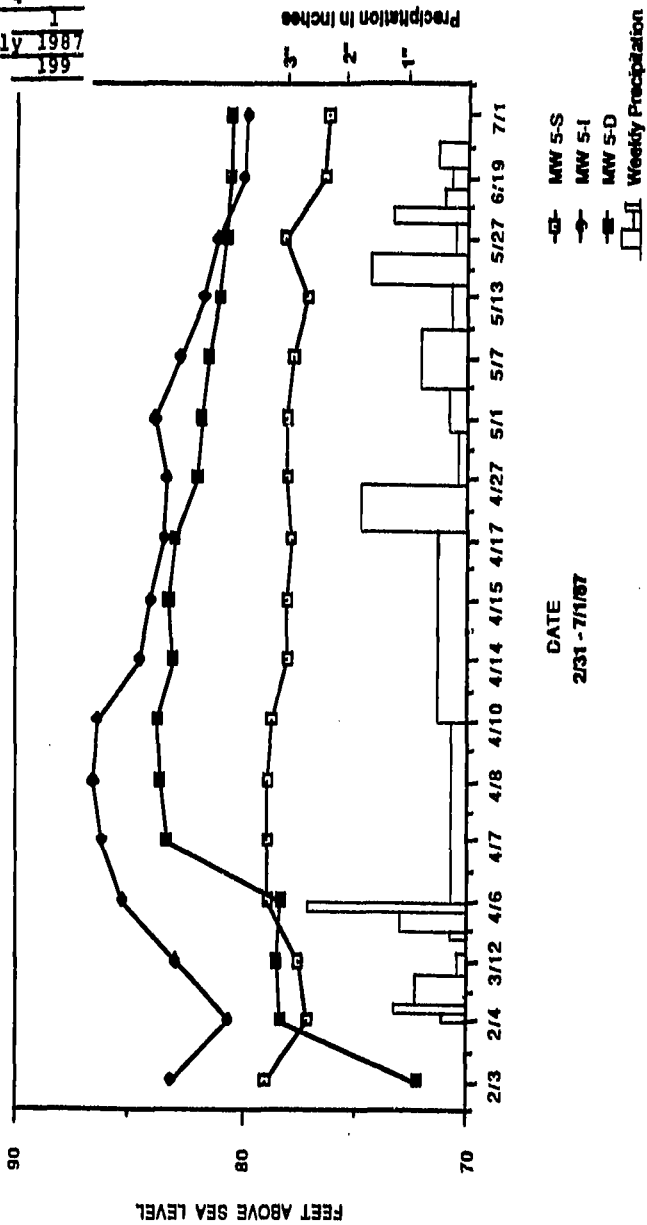
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**Figure 4-10**  
**Elevation of Piezometric Surface: Well Nest 5**  
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intermediate and deep zone levels. Hydrographs for each well nest are included as part of Appendix H.

The water level measured at well nests 2, 7, and 12 did not indicate an upward flow gradient. Except for the July 1986 monitoring event, all water level data for well nest 2 reflect a vertical downward gradient. The upward gradient observed in July 1986 is attributed to seasonal fluctuations within the bedrock aquifer. Lower precipitation and higher evapotranspiration associated with the summer lead to a reduction in the water level elevation which was more significant in 2-S than 2-I.

At well nests 7 and 12, located near the eastern end of the site, slight downward gradients were measured throughout much of the investigation. The hydrographs for well nest 7 (Figure 4-11), from data collected in 1987, show that the relationship between 7-S and 7-I was consistent with a downward gradient. The average difference between the two water level elevations was 0.22 feet. The water level in well 7-D, however, showed a constant upward trend between February and May 1987. By May, the water level elevation in Well 7-D was nearly equal to the two shallower wells. As of July 1987, the hydraulic head of all three wells varies little, with a total range of 0.2 feet. The water level elevation monitored at well nest 12 consistently indicated a slight downward vertical flow gradient. Water elevations in Well 12-S ranged from 0.01 to 1.45 and average 0.87 feet higher than 12-D over the period of investigation.

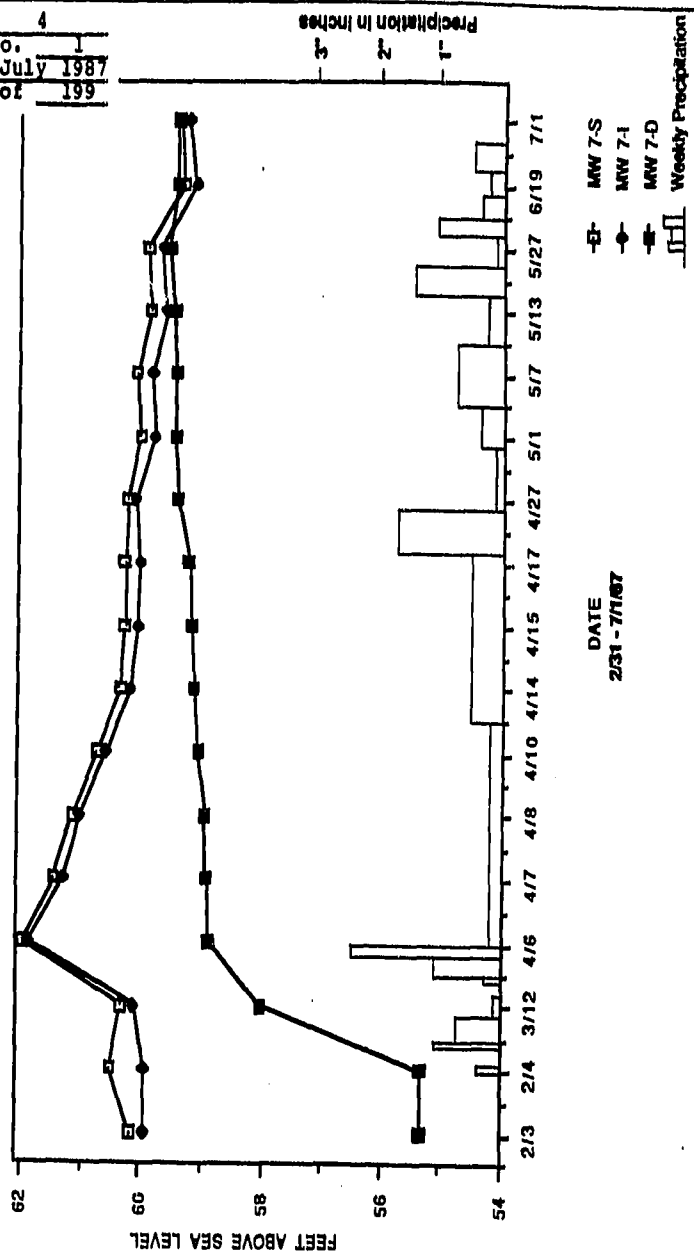
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**Figure 4-11**  
**Elevation of Piezometric Surface: Well Nest 7**  
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#### 4.2.2.4 Relationship with the Schuylkill River

The relationship of the Schuylkill River to the site's hydrogeology is important as upward vertical flow gradients were determined at well nests 8, 10, and 11 along the river. This indicated that ground water was discharging to the river. Hydrostatic levels at these well locations ranged from 2.41 (in the shallow well zone) to over 20 feet (in the deeper zones) higher than the water level elevation of the river. Although water levels at well nests 7 and 12, also located along the river bank in the eastern portion of the site, exhibited slight downward gradients, the shallow zone level still indicate discharge to the river. Hydrostatic levels in 7-S and 12-S ranged from 0.78 to 2.13 feet above the River's elevation. The deeper wells at these two locations typically exhibit lower hydrostatic levels than the River.

River piezometers were installed in April 1987 as described in Section 3.28 to further evaluate the relationship between the river and the ground water. As shown on Figure 3-4, Piezometers 1, 5, 8, 3, and 4 were located along the southern bank of the river. The water levels measured in these piezometers were higher than the level of the River, therefore an upward flow gradient is indicated. For these 5 piezometers, on July 1, 1987, the hydraulic head ranged from 0.11 to 0.87 feet above the river's water elevation. These measurements are representative of equilibrated water levels following piezometer installation. All piezometer water elevations are listed in Appendix H.

Piezometers 2, 6, and 7 were located on the south bank of Barbadoes Island (north of the river channel) and did not exhibit

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an upward flow gradient on July 1, 1987. However, water level elevations in piezometers 6 and 7 continue to rise slowly following their installation, which may indicate that they have not yet reached static conditions. The hydraulic head measured at piezometer 2 was 0.1 feet below the river's water elevation.

In summary, the upward ground water flow gradients determined at most well nests along the river bank are indicative of a ground water discharge zone. All of the piezometers installed along the southern river bank show an upward gradient, including piezometer 4 located next to well nest 7. Only the two deeper zone installations of well nests 7 and 12 exhibit downward hydraulic heads along the river bank.

#### 4.2.2.5 Response to Precipitation

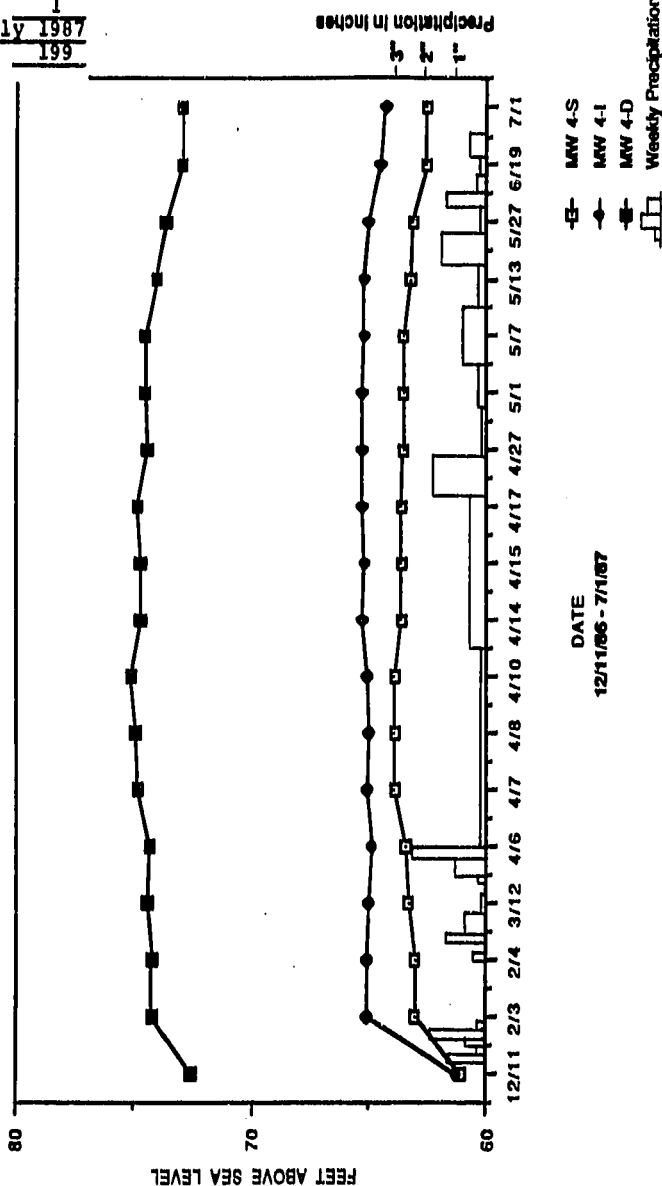
Figures 4-10, 4-11, and 4-12 illustrate the temporal variation of the piezometric surface in the bedrock aquifer at well nests 5, 7, and 4 in 1987. The water level elevations for each well within the nests have been plotted versus precipitation measured at the Montgomery County Landfill over the same time period (Appendix H). The Montgomery County Landfill is located approximately 3 miles southeast of the site where precipitation data was collected by the Philadelphia Suburban Water Company (Philadelphia Suburban Water Company, 1987). As shown on the hydrographs for well nests 5 and 7, water elevations in the shallow and intermediate wells respond readily to precipitation events in March and April. Well 5-D also shows a significant response to these precipitation events. As discussed above, well 7-D continued to rise through much of the 1987 record. Well nests 5 and 7 are typical of the relationship between

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**Figure 4-12**  
**Elevation of Piezometric Surface: Well Nest 4**  
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precipitation and water elevations at well nests 2, 3, 6, 8, 10, 11, 12 and the background well 1 (Appendix A). Seasonal variations reflected in these hydrographs show that high precipitation in the spring of the year results in ground water recharge and hence higher water level elevations. Similarly, a decrease in precipitation coupled with increasing evapotranspiration is reflected by decreasing ground water levels.

In comparison to the other well nest locations, the hydrographs for wells in nest 4 (Figure     ) and 9 (Appendix H) exhibit low amplitude changes throughout the period of record in response to precipitation. This may be indicative of low permeability in the bedrock aquifer at these sites, reducing the effectiveness of ground water recharge from precipitation.

It is important to note that the fluctuations observed in the water levels of artesian flowing wells such as 5-S, 5-I, and 5-D indicate that equilibrium conditions were obtained following the installation of piezometer tubes described in Section 3.2.2. These fluctuations are also apparent in the hydrographs for all of the other artesian wells for which piezometer tubes were installed (Appendix H).

#### 4.2.3 Aquifer Testing

Four different types of testing were performed on the bedrock wells installed at the site. These tests included slug tests, step drawdown tests and a long-term pump test. This testing was conducted to evaluate the hydraulic properties of the bedrock aquifer such as transmissivity, hydraulic conductivity, well

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yields, and the influence of pumping. In the following section, the methods of aquifer test analysis and results will be discussed in a summary fashion. It should be noted that most of the aquifer test analyses were completed by Papadopoulos & Associates (1987) and are included as Appendix I. Papadopoulos & Associates' (1987) Report provides a detailed discussion of methods of analysis and corresponding results.

#### 4.2.3.1 Slug Testing

The slug tests were conducted according to procedures described in Section 3.2.2 and were used to approximate hydraulic conductivity and transmissivities values. In addition to those well described above, the slow recovery of water elevations in wells 4-S, 5-D and 7-D, following their installation in 1986 was treated as a long-term slug test. These wells had recovery periods ranging from about 120 days in well 4-I to 170 days in 7-D. The slug test data was analyzed using the type-curve method of Copper and others (1967). The results of the slug tests and other types of aquifer testing conducted at the site, are summarized on Table 4-1. Slug test data are included as part of Appendix J.

#### 4.2.3.2 Step Drawdown Tests

Step drawdown tests were conducted on selected wells to determine a range of sustainable yields that could be anticipated in the event a ground water recovery program is initiated and to estimate the properties of hydraulic conductivity and transmissivity. Plots of the time versus drawdown data are included in Appendix K. The sustained yield for the shallow

TABLE 4-1  
AQUIFER TESTING RESULTS

WELL #	STEP TEST WELL YIELD (gpm)	OPEN INTERVAL TRANSMISSIVITY (ft <sup>2</sup> /d)	LENGTH OF OPEN INTERVAL (ft)	HYDRAULIC CONDUCTIVITY (ft/d)	ANALYSES* METHOD
2-S	1.5-2.5	24	21.5	1.1	step test**
2-I	10	150	25	6	step test**
3-S	1	28	21	1.3	step test
3-I	<1	0.7	24	0.029	slug test
3-D		0.21	52	0.004	slug test
4-S	<1	2.3	30	0.077	step test
4-I		0.014	26	0.00054	long term slug test
5-S	9-10	210	30	7	pump test recovery
5-I	<1	-	32	0.12	estimated from 6-I
5-D		0.0078	24	0.00033	long term slug test
6-S	1-1.5	9.1	20	0.46	step test
6-I		2.4	20	0.12	slug test
7-S	<1	1	42	0.24	step test
7-I	1	3.7	20	0.19	
7-D		0.0088	25	0.00035	long term slug test
8-S	8.0	180	30	6	step test
8-I	<1	1.1	20	0.055	step test
9-S		65	40	1.6	slug test
9-I		0.009	40	0.00023	slug test
9-D		0.03	35	0.00078	slug test
10-S		250	22	11	slug test
10-I		0.08	40	0.002	slug test
10-D		0.26	39	0.0067	slug test
11-S		4.5	40	0.11	slug test
11-I		2.2	40	0.055	constant rate test
11-D		0.06	40	0.0015	estimated from specific capacity
12-S		26	40	0.65	slug test
12-D		0.34	40	0.0085	slug test

NOTES

\* Test method chosen to obtain transmissivity values.

\*\* Step test analyses using first step.

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wells tested ranged from less than 1 gpm to a maximum of 10 gpm at well 5-S (Table 4-1). Well 5-S was subsequently selected for the long-term pump test. The yields for the intermediate wells ranged from less than 1 gpm, in five of seven wells, to a maximum of 10 gpm at well 2-I. Note that yields listed as less than 1 gpm on Table 4-1 indicated that a sustained yield was never achieved for the well. Sustained yields could not be achieved for any of the deep zone monitoring wells in the network.

The sustained yield measured for the three different aquifer zones indicated that the shallow zone was capable of producing more water than either the intermediate or deep zones. Although step tests were not completed at all wells in the monitoring well network, well yield observed while drilling and during development at each well support the above conclusion (as described in Section 3.2.1).

Step test data was analyzed utilizing two methods. The first pumping step was analyzed using the Cooper and Jacob (1946) straight line method. The second method used to analyze step test data was a generalized form of the Cooper-Jacob method applicable to step type pumping (1946). Correction were made to discharge rates in the second method to account for borehole storage effects.

#### 4.2.3.3 Constant Drawdown Testing

Utilizing the Jacob Lohman (1952) method the rate of discharge vs elapsed time was analyzed for well 11-I. The constant rate testing was also completed at well 11-D, however discharge rates increased with time and approached a steady rate near the end of

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the test. The Jacob and Lohman (1952) method is not applicable to this test data. For this well, it was assumed that the effective well radius and storage coefficient in wells 11-I and 11-D were similar, therefore determining the specific capacity of well 11-D at the end of test allowed open interval transmissivity to be calculated. Constant drawdown test data are included as part of Appendix J.

#### 4.2.3.4 Long-Term Pump Testing

The objective of the 7-day, long-term pump test was to determine the effect of long-term pumping on the configuration of the piezometric surfaces in the shallow, deep and intermediate flow zones. A second purpose of the test was to obtain, if possible, transmissivity and storativity values for the aquifer. All water level data obtained during the long-term pump test are included as part of Appendix L.

The long-term pump test was conducted by pumping Well 5-S at average rate of 9.0 gpm for a period of 7.7 days. The actual pumping rate fluctuated between 8.5 and 10.5 gpm over the course of the test. The pre-test water levels, end of test levels, and total drawdown for all wells in the monitoring network are listed on Table 4-2. The total drawdown in the pumping well was approximately thirty-nine feet over the seven days of pumping.

Four wells in the monitoring network, Wells 4-I, 5-D, 6-D, and 7-D, actually experienced a continual rise in water level over the course of the pump test. Figure 4-13 shows a time versus water level plot for 4-I and 5-D for the duration of the pump test. This plot indicates that the rate of water level rise

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TABLE 4-2  
PRE-PUMPING AND END OF TEST  
WATER LEVEL ELEVATIONS

Aquifer	Well No.	Elevation (ft. above MSL)		Total Drawdown (A)
		Before Test	End of Test	
Shallow	2-S	86.54	83.32	3.22
	3-S	78.53	77.09	1.44
	4-S	62.97	62.57	0.40
	5-S	77.89	38.86	39.03
	6-S	76.07	74.64	1.43
	7-S	59.66	59.61	0.05
	8-S	62.60	61.90	0.70
Intermediate	2-I	82.65	78.61	4.04
	3-I	77.08	75.63	1.45
	4-I*	56.62	58.90	-2.28
	5-I	81.73	77.68	4.05
	6-I	74.70	72.89	1.81
	7-I	59.57	59.47	0.10
	8-I	67.54	66.88	0.66
Deep	3-D	84.49	81.59	2.9
	4-D	73.46	73.20	0.26
	5-D*	60.19	64.83	-4.64
	6-D*	82.88	83.43	-0.55
	7-D*	33.81	41.35	-7.54

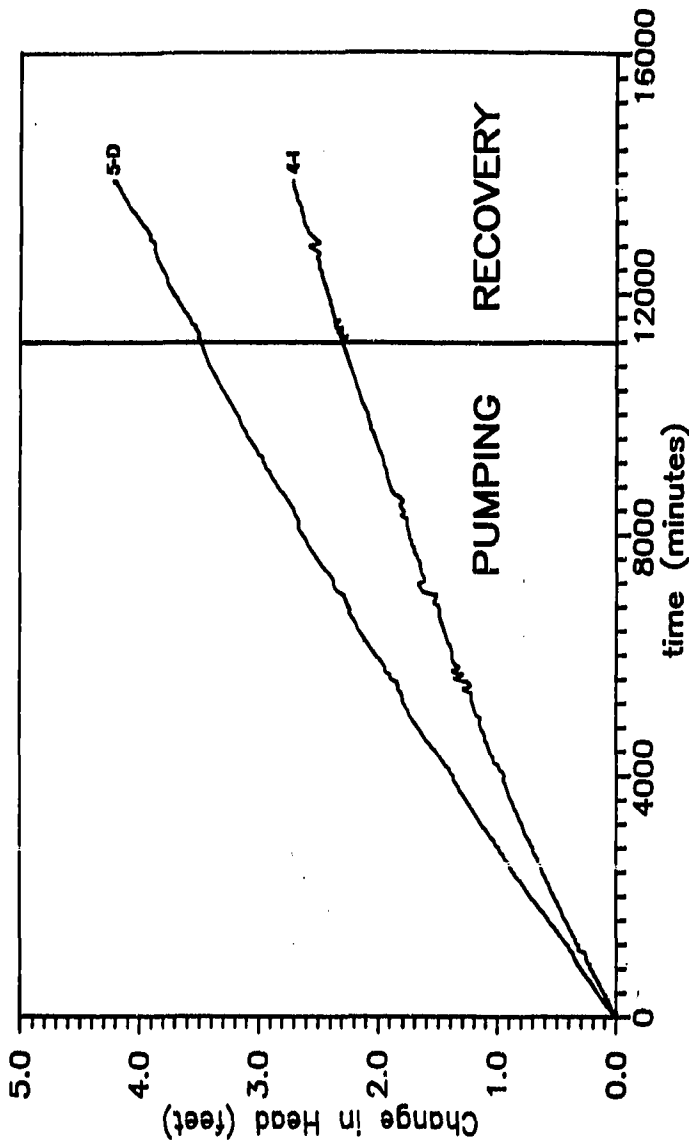
\*The ground water levels in these wells continued to rise throughout the pump test.

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**Figure 4-13**  
**Wells 4-1 and 5-D - Pumping and Recovery Periods**  
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showed little or no response to the effects of pumping. Wells 4-I, 5-D, and 7-D continued to recover for up to 170 days following a ground water sampling event in September 1986. The continual rise in water level during the long-term pump test indicates that portions of the zone(s) monitored by wells 4-I, 5-D, 6-D, and 7-D are characterized by low hydraulic conductivity. As seen on Table 4-2, water levels in other deep monitoring wells also showed little to no response to pumping.

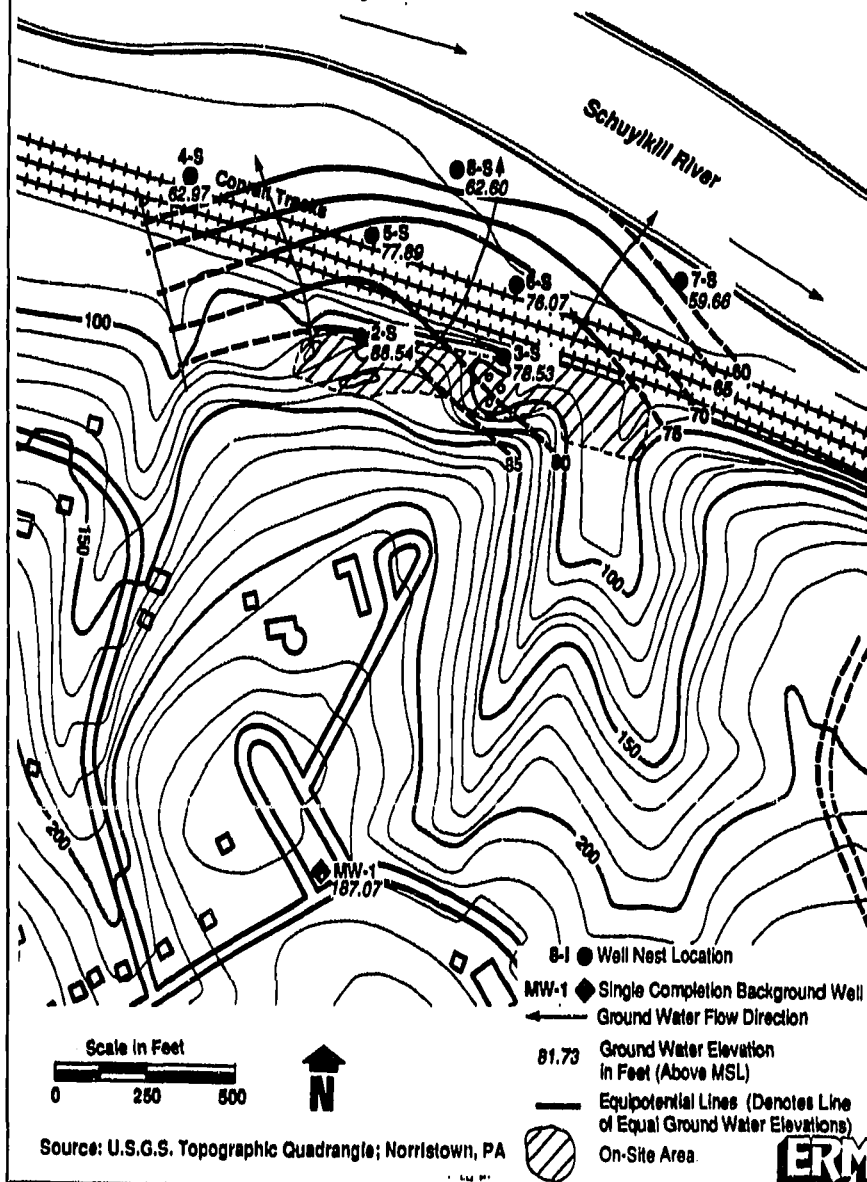
Pre-pumping and end of test piezometric surface maps were generated for the shallow and intermediate zones and are included as Figures 4-14 through 4-17. The maps illustrate several significant features. For the shallow zone, the direction of ground water flow previous to the test was generally south to north (Figure 4-14). The end of test piezometric surface shown on Figure 4-15 shows that a cone of depression was developed around Well 5-S.

Figure 4-16 is the pre-test piezometric surface map for the intermediate zone. The water level for Well 4-I was omitted because of the continual rise in water level over the duration of the test. The pre-test piezometric surface is similar in configuration to the pre-test map for the shallow zone, the direction of ground water flow is approximately to the northeast. The end of test piezometric surface map for the intermediate zone is shown on Figure 4-17. This map indicates the same general ground water flow direction as the pre-test map. In general, the piezometric surface for the intermediate zone was lowered in elevation. The drawdown in the intermediate zone, in response to pumping the shallow zone, ranged from a minimum of 0.1 at Well 7-I to a maximum of 4.05 at Well 5-I. The drawdown at Well 2-I

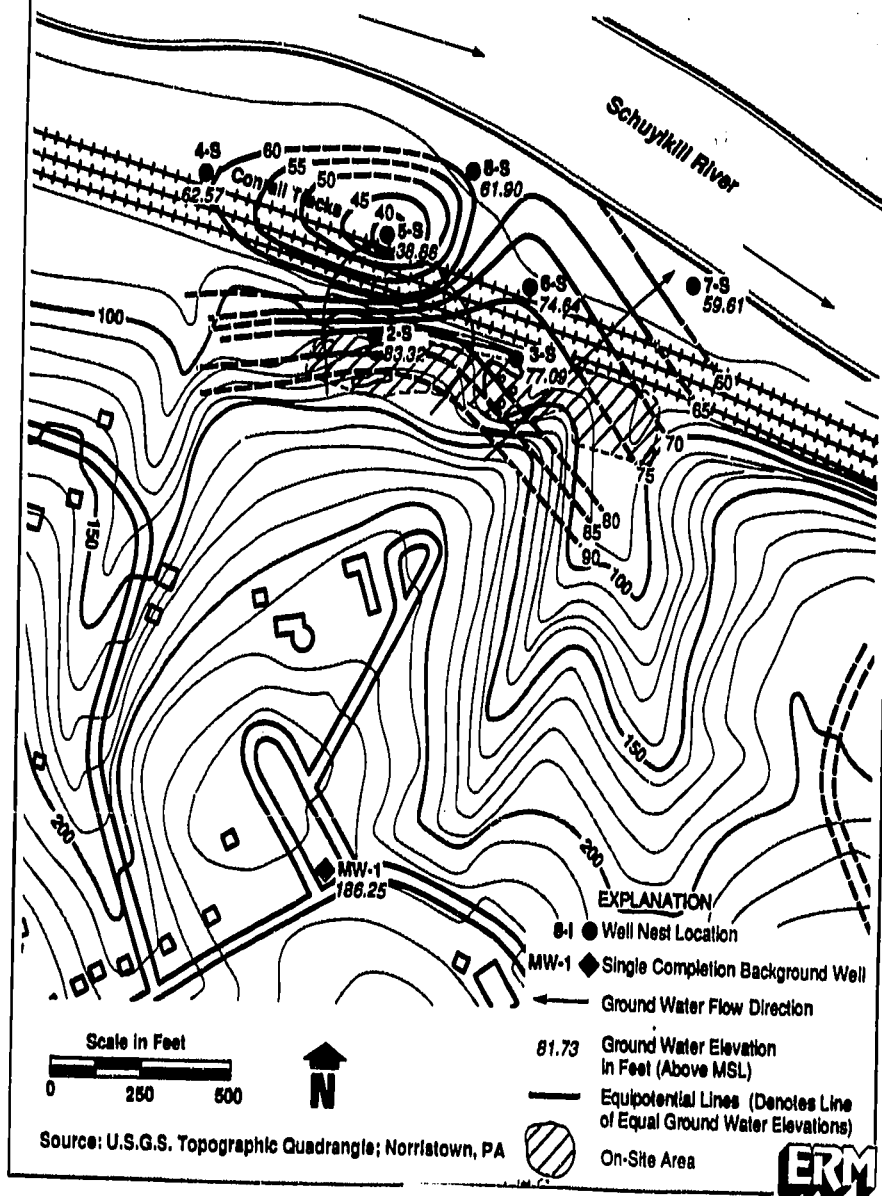
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**Figure 4-14**  
**Pre-Pump Test Piezometric Surface**  
**Shallow Wells**  
**Tyson's Site**



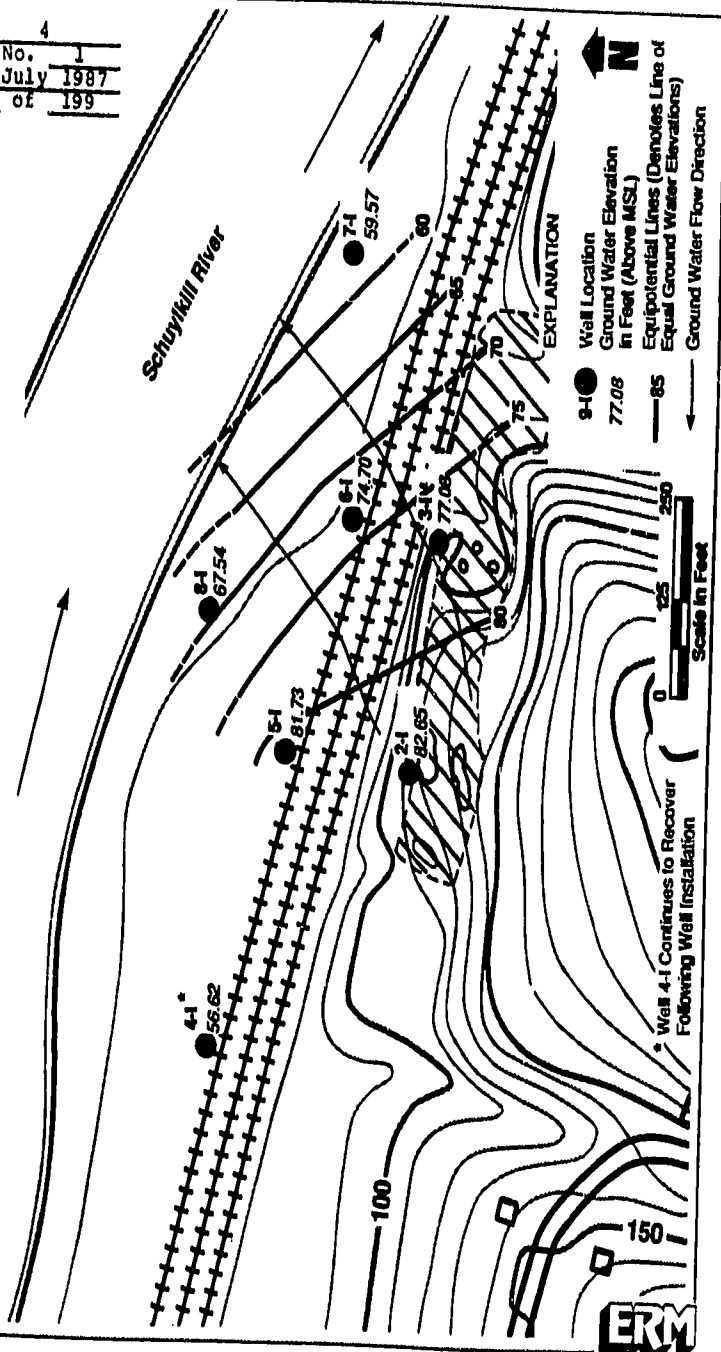
**Figure 4-15**  
**End of Test Piezometric Surface**  
**Shallow Wells**  
**Tyson's Site**



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Figure 4-16  
 Pre-Pump Test Piezometric Surface  
 Intermediate Wells  
 Tyson's Site

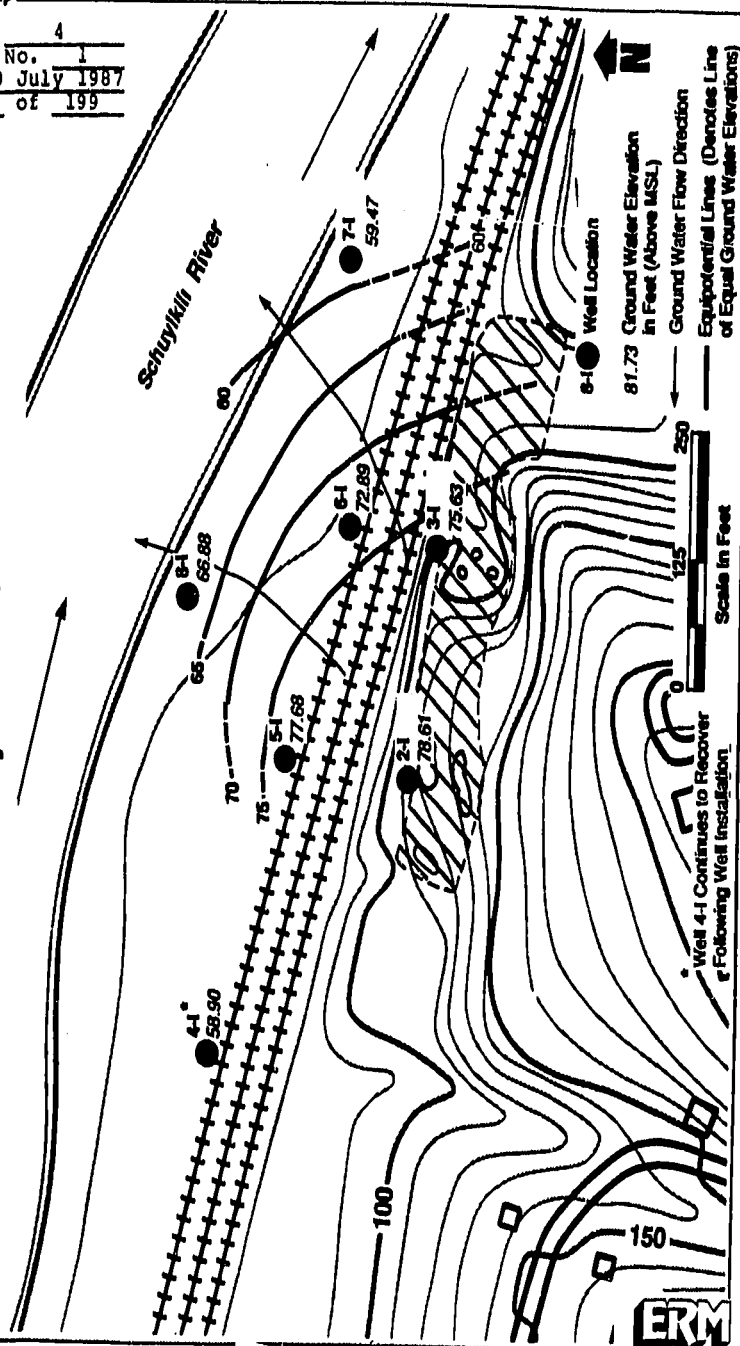


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**Figure 4-17**  
**End of Test Piezometric Surface**  
**Intermediate Wells**  
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was similar to that of Well 5-I, which had a drawdown of 4.04 feet.

Water level data collected during the pump tests were evaluated using the Theis Curve Matching Technique to obtain transmissivity and storativity values for the aquifer. However, the application of traditional pump test analysis techniques to a non-homogeneous fractured bedrock aquifer may result in the calculation of unrepresentative transmissivities. The transmissivities calculated utilizing the Theis curve matching techniques were significantly higher than values obtained from the single well methods previously described. Therefore, the calculated results of the long-term pump test were considered not to be representative of this bedrock aquifer.

In addition, the transmissivity of the shallow zone at Well 5-S (pumping well) was determined by analyzing recovery data. The recovery data was evaluated using the Theis (1935) recovery method.

#### 4.2.3.5 Discussion of Results

The analyses of slug test, step test, constant rate tests and long term pump testing data resulted in the calculation of hydraulic conductivity and transmissivity values for the three zones in the bedrock aquifer. These values are reported on Table 4-1. For those wells in which more than one test or analysis was conducted, the values deemed most reliable are reported. In general, the values obtained by analyses of slug tests, step tests and constant rate tests were similar and were considered more reliable than the results from the long-term pump test.

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Aquifer test data were not available for wells 4-D, 5-I, 6-D, 8-D and 10-XD. For well 5-I, the hydraulic conductivity included on Table 4-1 was assumed to be similar to that of the nearby well 6-I. The transmissivity and hydraulic conductivity for wells 4-D, 6-D, 8-D and 10-XD were not estimated. However, they are assumed to be negligible for the following reasons:

- Minimal calculated transmissivities for wells 4-I, 6-I, 8-I, and 10-D
- Low yield observed during the installation of deep wells (only 10-XD could sustain yield)
- Significant reduction in calculated transmissivity values with depth for well nests of which all three wells were tested

In order to determine the spatial distribution of transmissivities on site, the total transmissivity at each well nest was calculated using the following procedure. The hydraulic conductivity determined from the transmissivity of the open interval of each well was assumed to apply to a zone representative of that well. For shallow wells, the representative zone extended from the top of the saturated deep aquifer to the midpoint between the open intervals of the shallow and the intermediate wells at the well nest location. The representative zone for intermediate wells was taken as the distance between the bottom of the shallow zone and the midpoint between the open intervals of the intermediate and deep wells.

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the representative deep well zone was the distance between the bottom of the intermediate zone and the bottom of the open interval in the deep well. A representative transmissivity for each zone was calculated by multiplying the thickness of the zone by the hydraulic conductivity (see Table 4-3). The reported total transmissivity of the deep aquifer at each well nest location is the sum of the representative zone transmissivities.

The hydraulic conductivity values obtained were compared to ranges of values for different types of geologic materials published in Freeze and Cherry (1979, p.29). According to the text, the range of K values for all three zones is generally consistent with the range of values for sandstones (0.0013 to 1.3 ft/day). The calculated hydraulic conductivities for wells 2-I, 5-S, 8-S, 9-S, and 10-S slightly exceeded the published range for sandstones. The higher values are indicative of portions of the bedrock aquifer with a relatively high degree of secondary porosity. As might be expected, the group of wells for which the highest hydraulic conductivity were determined also represent those wells with the highest yields (excluding well 9-S). Also, each high yielding well is a shallow well, with the exception of well 2-I.

Hydraulic conductivity values determined from data collected at Wells 4-I, 5-D, 7-D, 9-I, 9-D are below the published values. These lower values are indicative of the decreasing permeability found with increasing depth as a result of reduced frequency of fracturing and weathering.

The average transmissivity values calculated for each aquifer zone further demonstrate the decreasing permeability with depth.

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TABLE 4-3

SUMMARY OF RESULTS - AQUIFER TESTING

<u>WELL #</u>	<u>HYDRAULIC CONDUCTIVITY</u>	<u>ZONE THICKNESS</u>	<u>ZONE TRANSMISSIVITY</u>	<u>TOTAL TRANSMISSIVITY OF EACH WELL NEST</u>
	(ft/d)	(ft)	(ft <sup>2</sup> /d)	(ft <sup>2</sup> /d)
2-S	1.1	45	50	380
2-I	6	55	330	
3-S	1.3	38	49	51
3-I	0.029	50	1.5	
3-D	0.004	65	0.26	
4-S	0.077	46	3.5	3.5
4-I	0.00054	49	0.026	
5-S	7	56	390	400
5-I	0.12	64	7.7	
5-D	0.00033	41	0.014	
6-S	0.46	38	17	22
6-I	0.12	42	5	
7-S	0.024	87	2.1	15
7-I	0.19	68	13	
7-D	0.00035	38	0.013	
8-S	6	68	410	410
8-I	0.055	56	3.1	
9-S	1.6	71	110	110
9-I	0.00023	78	0.018	
9-D	0.00078	50	0.043	
10-S	11	51	560	560
10-I	0.002	84	0.17	
10-D	0.0067	85	0.57	
11-S	0.11	80	8.8	13
11-I	0.055	69	3.8	
11-D	0.0015	55	0.083	
12-S	0.65	80	52	54
12-D	0.0085	63	1.5	

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The average shallow zone transmissivity is 150 ft<sup>2</sup>/day and the average intermediate and deep zone transmissivities are 36.4 and 0.35 ft<sup>2</sup>/day, respectively. This represents a three order of magnitude reduction in transmissivity with increasing depth.

The total transmissivity of the bedrock aquifer underlying the site was estimated to range from 3.5 ft<sup>2</sup>/day at well nest 4 to 560 ft<sup>2</sup>/day at well nest 10. Published values for transmissivities in the Stockton Formation average over 2000 ft<sup>2</sup>/day (Rima et al. 1962). These transmissivities were calculated for wells often installed as production wells with open intervals greater than 100 feet and yields of up to 500 gpm. The wells installed at the site are intended for water level and water quality monitoring and have average open intervals of 33 feet, excluding the 80-foot open interval for the background well. The difference in transmissivities is thought to be a result of the difference in the lengths of open intervals and hence the number of fractures intersected by each well.

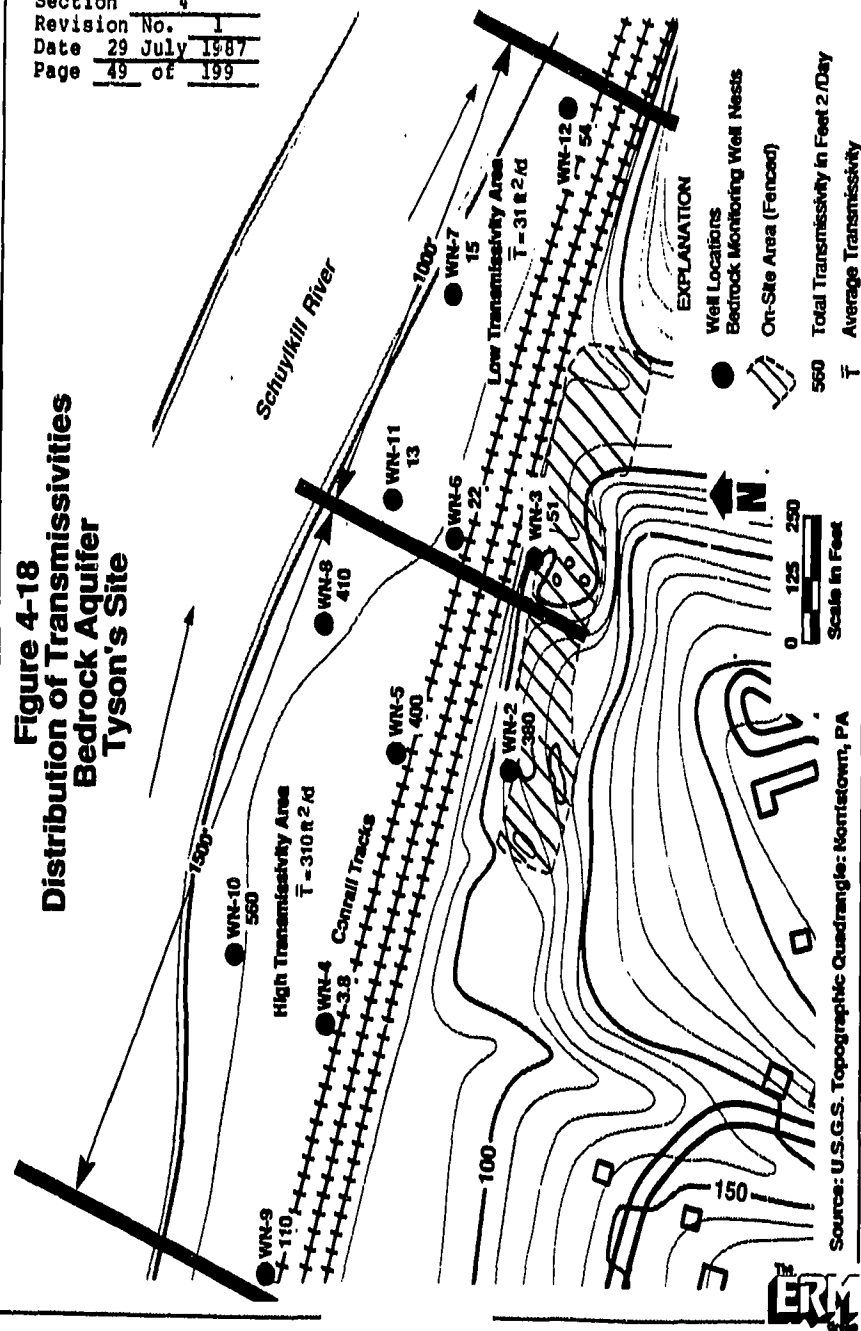
The distribution of bedrock aquifer total transmissivities calculated for the site area is shown on Figure 4-18. In general, total bedrock aquifer transmissivity values at well nests on the west side of the site are higher than those for well nest on the east side of the site. The area of relatively high transmissivity encompasses well nests 2, 4, 5, 8, 9, and 10. The average transmissivity within this area is 310 ft<sup>2</sup>/day. The area of relatively low transmissivity encompasses wells nest 3, 6, 7, 11, and 12. The average transmissivity in this area is 31 ft<sup>2</sup>/day.

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**Figure 4-18**  
**Distribution of Transmissivities**  
**Bedrock Aquifer**  
**Tyson's Site**



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The boundary between these two generalized transmissivity areas is not clearly defined. In order to estimate a conservatively high ground water flow rate through the bedrock aquifer, the boundary between the two areas was assumed to be closer to the well nest with low transmissivities. This assumption increases the width of the flow zone in which high transmissivities are found (see Figure 4-18).

#### Ground Water Flow Through the Bedrock Aquifer

The rate of ground water flow through the bedrock aquifer was calculated by applying Darcy's equation:

$$Q = TIW$$

Where:  $Q$  = Rate of Ground Water Flow ( $\text{ft}^3/\text{d}$ );  
 $T$  = Average transmissivity for area ( $\text{ft}^2/\text{d}$ );  
 $I$  = Average hydraulic gradient within the area  
(dimensionless); and  
 $W$  = Width of area (ft).

The total range of ground water flow downgradient of the site was obtained by summing the  $Q$  values for the high and low transmissivity areas.

Water-level data from the well nests indicate that the horizontal hydraulic gradients within the bedrock aquifer change with depth. The steepest gradients occur within the shallow interval of the bedrock aquifer. Therefore, to be conservative, the gradients within the shallow interval of the aquifer were selected as

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representative of the average hydraulic gradient for the bedrock aquifer. Based on water-level measurements made in shallow wells on April 17 1987, the average hydraulic gradients for the high and low transmissivity areas of the aquifer were estimated to be 0.044 and 0.038, respectively.

For the flow calculation, the width of the area of interest encompassed all well nest as shown on Figure 4-18. This resulted in a 1,500-foot wide high transmissivity area and a 1,000-foot wide low transmissivity area.

Using the average gradients, area widths and average transmissivities discussed in the previous section, the rate of ground water flow through the bedrock aquifer was calculated to be 20,500 ft<sup>3</sup>/d in the high transmissivity area and 1,200 ft<sup>3</sup>/d in the low transmissivity area. Thus, the total rate of ground water flow through the deep aquifer downgradient of the site is estimated to be 21,700 ft<sup>3</sup>/d.

#### 4.2.4 Occurrence and Behavior of DNAPL in the Bedrock Aquifer

##### 4.2.4.1 Movement of DNAPL in the Bedrock Aquifer

The lagoons used for the disposal of liquid wastes were constructed on a bedrock terrace south of the railroad tracks. The location and configuration of the lagoons was likely dictated by the locally variable rippability of weathered bedrock on the terrace. Both weathering and rippability are related to the amount of fracturing at a specific location. The lagoons would have been constructed in areas with a locally increased amount of

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fracturing. When the liquid wastes were disposed in the lagoons, they rapidly moved downward through the fractures. It has been established that a proportion of the liquid waste existed in the form of a DNAPL.

Three samples of the DNAPL were collected to characterize its chemical and physical properties. The results are presented on Tables 4-4 and 4-5. 1,2,3-trichloropropane, was determined to be 23.0 percent by weight and 73.0 percent by weight in Wells 3-I and 8-I, respectively. The other compounds found in these samples were xylene, ethylbenzene and toluene. Unidentifiable petroleum distillates constituted 20 percent of the sample at 8-I and about 52 percent of the sample from Well 3-I. The DNAPL had a measured viscosity of 3 and 7 centpoise/second (cps). This viscosity is greater than water (1 cps at 20°C), but considerably less than 30 weight motor oil of 300 cps (Mott, 1979). The specific gravity of the DNAPL was 1.125 and 1.30 gm/cm<sup>3</sup> for Wells 3-I and 8-I, respectively.

Analyses for corrosivity, reactivity and ignitability were undertaken to determine whether the DNAPL had any hazardous properties. The DNAPL had a nearly neutral pH of 7.23 and did not generate detectable quantities of either cyanide or sulfide during reactivity testing. The DNAPL is considered a flammable liquid because its flash point is less than 140°F (40 CFR 261.21).

Sandbox experiments conducted by Schwillie (1984) demonstrated that pure tetrachloroethylene migrated vertically through 2 feet of unsaturated coarse grained sand in 10 minutes. A similar experiment conducted with water saturated sand demonstrated that

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TABLE 4-4  
 DNAPL COMPOSITION AND PROPERTIES

	<u>Well 3-I</u>	<u>Well 8-I</u>
	% by Weight	
1,2,3-Trichloropropane	23.0	73.0
Xylenes	17.0	5.8
Ethyl benzene	3.8	0.9
Toluene	4.2	0.9
	<u>48.0%*</u>	<u>80.6%**</u>
Brookfield Viscosity	3. cps	7. cps
Specific Gravity	1.125 gm/cm <sup>3</sup>	1.30 gm/cm <sup>3</sup>

\*The balance of the sample composition were compounds eluting later than xylenes, but not in an elution pattern identifiable as petroleum distillates.

\*\*The balance of sample composition was typical of unidentified petroleum distillates. Petroleum distillates can be identified as a general class of compounds because of the characteristic hydrocarbon envelope that is obtained during gas chromatographic analysis of samples containing these analytes.

It is accurate to "the pattern is typical of petroleum distillates" as a qualitative statement. What is unidentifiable as the exact collection of hydrocarbon compounds that constitute a particular hydrocarbon envelope.

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TABLE 4-5

TYSON'S SITE  
DNAPL CORROSIVITY, IGNITABILITY AND  
REACTIVITY

<u>Analyses</u>	<u>Results</u>
Corrosivity*	
pH	7.23
Reactivity**	
Cyanide (Total)	ND
Sulfide	ND
Ignitability***	
Flash Point	101°F

Notes:

- \* The pH of a 1:1 slurry (with deionized water) was 7.2 indicating that the waste is not corrosive. A waste is corrosive if it exhibits a pH equal to or less than 2 or greater than 12.5.
- \*\* The acidified sample was distilled and the resulting vapor were absorbed in a sodium hydroxide solution. This solution was analyzed for cyanide and sulfide. This waste is not considered reactive and hazardous because it does not generate a quantity of cyanide exceeding 250 ppm or sulfide exceeding 500 ppm. These interim threshold limits were established by the Solid Waste Branch of EPA, July 12, 1985.
- \*\*\* Test flame enhanced at 87°F. Flash point was determined using Pensky Martens closed cup apparatus.

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pure TCE migrated downward through 3 feet of material in 60 minutes despite a simulated horizontal ground water flow of 50 feet per day.

Feenstra and Cherry (1986) indicated that the DNAPL would have sunk rapidly until it encountered a relatively impermeable boundary such as a shaley interbed or a point where permeability was reduced. They had also indicated that once the DNAPL encountered the relatively impermeable surface, it either pooled in low spots on the impermeable surface or moved downgradient along the surface. Some of the DNAPL would and did escape as seeps out of the bedrock outcrop south of the railroad tracks along bedding planes.

What is believed to be a much greater portion of the DNAPL continued to move vertically downward until it encountered relatively impermeable surfaces at greater depths. Again, some of the DNAPL probably pooled in low spots along impermeable surfaces while some moved downgradient, along the impermeable surfaces into the bedrock aquifer underlying the floodplain. The relatively impermeable surfaces are discontinuous and juxtapositioned to one another. This means that DNAPL moving downgradient along the impermeable surface would reach the end of the surface and begin sinking again until it reached the next, underlying impermeable surface in a "stair-step" manner. This process would continue until the DNAPL reaches a continuous, impermeable layer at depth, such as a major shale or simply the closing of fractures at depth.

Ground water flow patterns in the deep aquifer will have no effect on the movement of DNAPL through the bedrock. In

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laboratory experiments by Schwille (1984), the downward penetration of DNAPL chemicals such as trichloroethylene (density 1.47 g/cm<sup>3</sup>) and tetrachloroethylene (density 1.63 g/cm<sup>3</sup>) into coarse and medium sand was not noticeably influenced by horizontal ground water velocities of as much as 46 ft/day. Ground water velocities within the deep aquifer are much less than this value.

Under conditions where hydraulic gradients are upward such as exist near the Schuylkill River, upward movement of DNAPL into the river can only occur when the upward hydraulic gradient is sufficiently large to counteract the downward force due to the density of the DNAPL. The magnitude of the required upward hydraulic gradient can be calculated by:

$$\frac{h}{L} = \frac{(DNAPL - w)}{w}$$

where  $h/L$  is the hydraulic gradient defined by the difference in hydraulic head,  $h$ , along a column of DNAPL of length  $L$ ,  $DNAPL$  is the density of the DNAPL and  $w$  is the density of the water. The derivation of this formula is shown in Appendix M. The DNAPL chemical identified in Well 8-I had a density of 1.3 g/cm<sup>3</sup>. Therefore, an upward hydraulic gradient of at least 0.3 would be required to induce upward movement of DNAPL into the Schuylkill River. Upward gradients of this magnitude do not exist in the deep aquifer so that upward movement of DNAPL into the river will not be possible. This view is supported by the finding of low concentrations of site-derived compounds in the bottom sediments of the river.

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DNAPL was measured in the bottom of many wells (2-S, 3-S, 3-I, 5-S, 6-S, 6-I, and 8-I) and the range of measured thicknesses is represented on Figure 4-19. The ranges given do not represent the volume of DNAPL in the formation, but indicate DNAPL accumulation in the borehole. Accumulation of DNAPL varied with the pumping activities conducted at each well. It is noteworthy that DNAPL was encountered at a depth of 140 feet in the deep aquifer at Well 8-I at a distance of approximately 50 feet from the south bank of the Schuylkill River. The extent of DNAPL migration below and possibly north of the river remains unknown.

Figure 4-20 is a generalized diagram (Feenstra and Cherry, 1986) illustrating the pathway of migration of DNAPL and resultant contamination of ground water in an aquifer. As the DNAPL sinks, part of it becomes entrapped in the spaces provided by primary and secondary porosity. In the unsaturated vadose zone, above the water table, the entrapped DNAPL occurs in available spaces with air and water. As DNAPL continues to sink below the water table, entrapped DNAPL occurs in available space with ground water only. As discussed above, the DNAPL sinks until it reaches a surface of relatively low permeability. Here the DNAPL will accumulate and either pool or move downgradient along the surface. As DNAPL accumulates, all available space becomes saturated with the DNAPL, displacing all ground water.

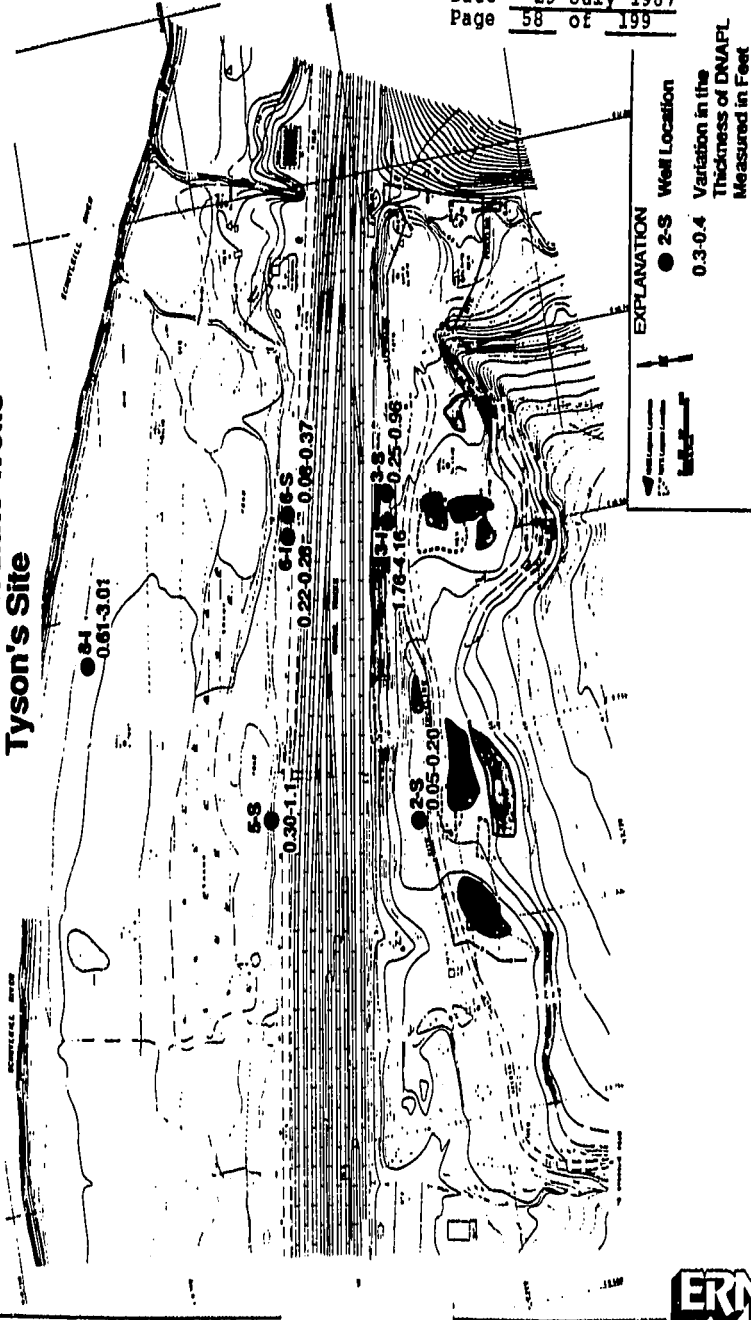
#### 4.2.4.2 DNAPL Dissolution in Ground Water

Entrapped DNAPLs provide a continuing supply of dissolved organic constituents to further contaminate the aquifer. Any ground water that comes in contact with the DNAPL becomes contaminated

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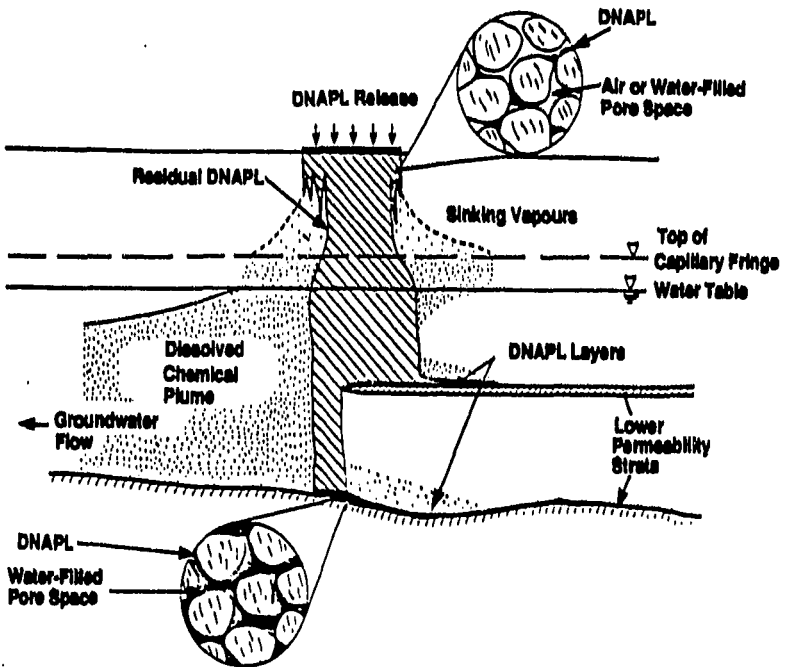
**Figure 4-19**  
**DNAPL Thickness Ranges in**  
**Shallow and Intermediate Wells**  
**Tyson's Site**



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**Figure 4-20**  
**Ground Water Contamination from**  
**Residual DNAPL and DNAPL Layers**



Groundwater Contamination from Residual DNAPL and DNAPL Layers.  
Feenstra, S. and Cherry, J.A., 1986)

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with its dissolved constituents. Once the DNAPL has passed through the aquifer, ground water comes in contact with entrapped DNAPL along the entire pathway of DNAPL movement: percolation from the surface is contaminated by DNAPL entrapped in the vadose zone; ground water moving in the aquifer is contaminated by DNAPL entrapped in the aquifer, above accumulated DNAPL; and, ground water moving across the surface of an accumulated DNAPL becomes contaminated. The ultimate concentration of dissolved constituents is determined by several geochemical factors which limit the solubility of the constituent in ground water.

The occurrence of entrapped DNAPL in the aquifer represents an infinite supply of dissolved DNAPL constituents as was demonstrated by analyses of ground water samples collected during the seven-day pump test of Well 5-S. Results of laboratory and field GC analyses for water quality samples taken throughout the long-term pump test are shown in Table 4-6. The concentration of 1,2,3-trichloropropane reported by the Laboratory varied between 110 ppm to 230 ppm. In general, the data showed no improvement in ground water quality from the beginning to the end of the test and the values from Lancaster Laboratories actually indicate a slight increase in 1,2,3-trichloropropane concentration at the end of the test.

#### 4.2.5 DNAPL Recovery Testing

Three types of testing were conducted at the site to investigate various aspects of recovering DNAPL from the aquifer. Two types of tests were each conducted on Wells 8-I and 3-I. These included a DNAPL purge test and a hydrostatic head reduction test. The purpose of the purge test was to determine if sustained

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TABLE 4-6  
WATER QUALITY RESULTS  
DURING LONG-TERM PUMP TEST  
AT WELL 5-S

Lapsed Time (hrs.)	Field GC Results Trichloropropane (ppm)	Laboratory Results Trichloropropane (ppm)
0	117	120
6	200	
12	194	210
18	216	
24	221	210
30	210	
36	194	220
42	263	
48	166	190
54	175	
60	156	200
66	140	
72	187	207
78	254	
84	267	110
90	283	
96	233	193
102	330	
108	267	188
114	204	
120	181	196
126	200	
132	233	205
138	224	
144	140	183
150	201	
156	210	220
162	200	
168	240	220
174	163	
180	243	220
186	222	230

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recovery of DNAPL could be achieved by using a simple gravity based system. During purging and the 24 hours following purging, the thicknesses of DNAPL in the well was measured at regular intervals.

In the second test the hydrostatic head was reduced within the well by pumping to determine whether the effects of upconing would enhance DNAPL accumulation. In work completed by J. F. Villaume, et. al., (1983) the reduction in the level of the static water table around a recovery well resulted in the upconing of coal tar in the recovery well and improved rates of coal tar recovery.

The hydrostatic head in Wells 8-I and 3-I was reduced using a submersible pump. A conductivity probe for measuring the thickness of DNAPL was inserted into a gauging tube which allowed accurate measurements of DNAPL thickness throughout testing. The thickness of DNAPL was measured at regular intervals throughout the test and up to several days after pumping ceased.

DNAPL thickness monitoring was also conducted during the long-term pump test on Well 5-S. A gauging tube, similar to that installed in Wells 8-I and 3-I, was installed in Well 5-S two feet below the pump intake. The level of DNAPL in Well 5-S was measured at regular intervals to determine if any accumulation was occurring over the seven day period. Results are discussed in Section 4.2.5.3.

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#### 4.2.5.1 Purge Tests

Seven gallons of DNAPL and a small quantity of water were purged from Well 8-I with the air-activated purge pump. This volume of DNAPL exceeded the expected volume by three gallons. This would indicate that the purged DNAPL was in storage outside of the borehole or that the borehole dimensions are larger than the normal size of the drill bit. The Lower Member of the Stockton is not typically well cemented and, based on the observations made during well installation on site it is likely that the dimensions of the borehole increased during drilling and well development. This may further explain why there was no measurable DNAPL recharge following the cessation of pumping. If DNAPL in storage outside the borehole accounted for the additional DNAPL purged, it would be anticipated that continued recharge of DNAPL would cease following the cessation of pumping.

The response of the DNAPL purge test in Well 3-I was similar to the response seen in Well 8-I. DNAPL accumulation measurements recorded over the 24-hours following the removal of DNAPL from Well 3-S, showed no measurable accumulation of DNAPL in the well.

#### 4.2.5.2 Hydrostatic Head Reduction Tests

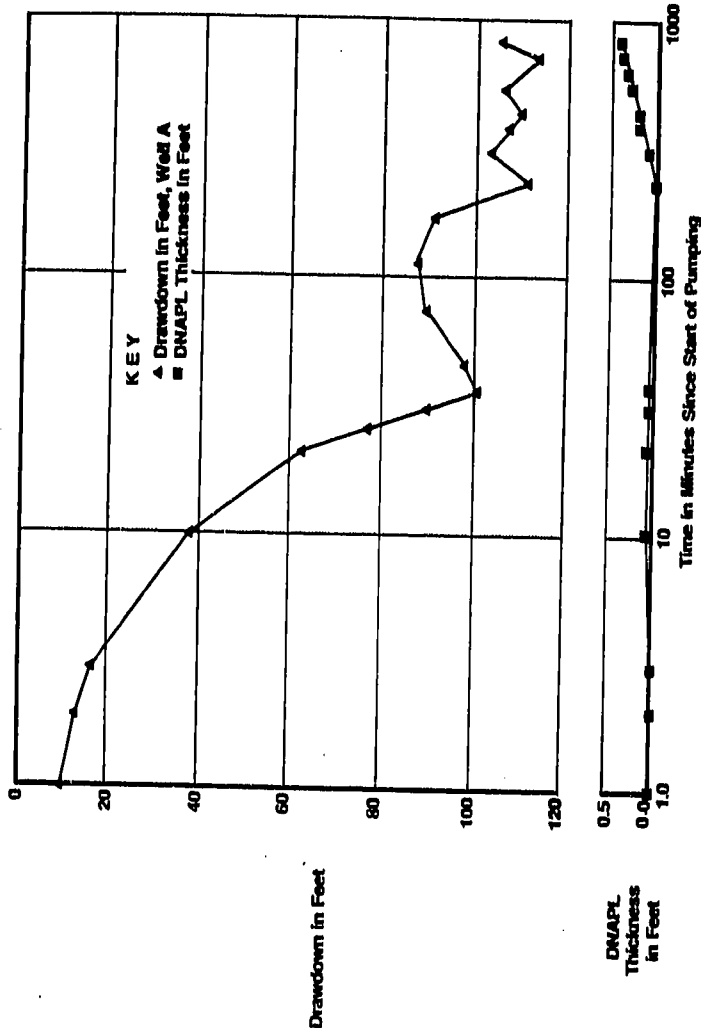
Figure 4-21 depicts the results of the hydrostatic head reduction test on the accumulation of DNAPL in Well 8-I and shows a plot of water level drawdown, due to pumping, and the accumulation of DNAPL versus time on a logarithmic scale. The pump intake was set at 120 feet during the early stages of testing at Well 8-I, five feet into the open borehole. This created unnecessary turbulence which caused mixing of the DNAPL and purge water. It

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**Figure 4-21**  
**Well 8-1**  
**Drawdown vs. DNAPL Accumulation**



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was observed that up to 30 percent of the purged water was DNAPL. To eliminate turbulence, the pumping rate was reduced to 0.5 gpm and the pump intake raised to within the cased portion of the well. The water level in the well was allowed to recover nearly fifteen feet. The result was a reduction of unintended pumping of DNAPL by 20 percent, but not total elimination.

In an effort to induce DNAPL accumulation, the pumping rate was then increased to one gpm, with a reduction in the pumping water level to a depth of about 110 feet. Soon thereafter, approximately 300 minutes from the start of pumping, measurable DNAPL accumulation was observed in the bottom of the well. The water level in the well was sensitive to minor variations in the pumping rate; therefore, constant adjustment was needed to maintain a static head between 105 and 115 feet. The average pumping rate during the first 300 minutes of the test was 1 gpm. From 300 minutes to the end of pumping, the DNAPL accumulation in the well appeared to be linear, reaching a maximum thickness of 0.43 feet. The test lasted for 800 minutes at which time pump failure ended the test. The following day, approximately 9 hours following the cessation of pumping, DNAPL accumulation in Well 8-I had increased to 0.54 feet. When this measurement was taken the water level in the well was about 1 foot below its pre-pumping level.

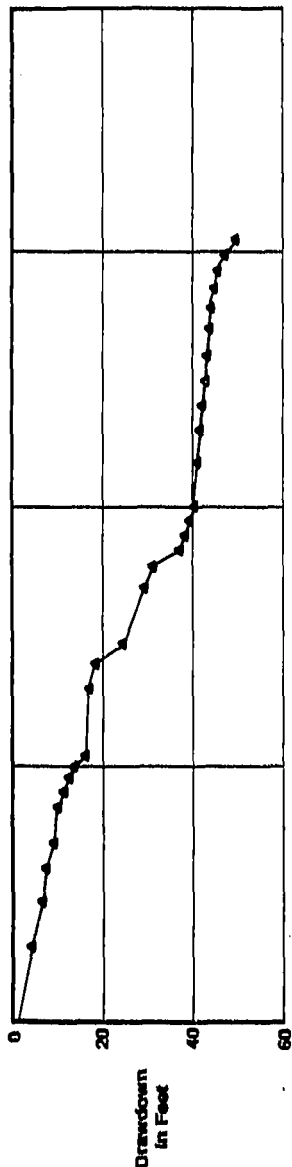
The results of the hydrostatic head reduction test on Well 3-I were also similar to the results of this test on Well 8-I. Figure 4-22 is a plot of drawdown and the accumulation of DNAPL versus time on the logarithmic scale for Well 3-I. The pump intake was set at 50 feet below the static water level within the cased portion of the well. One hour variable pumping rates of

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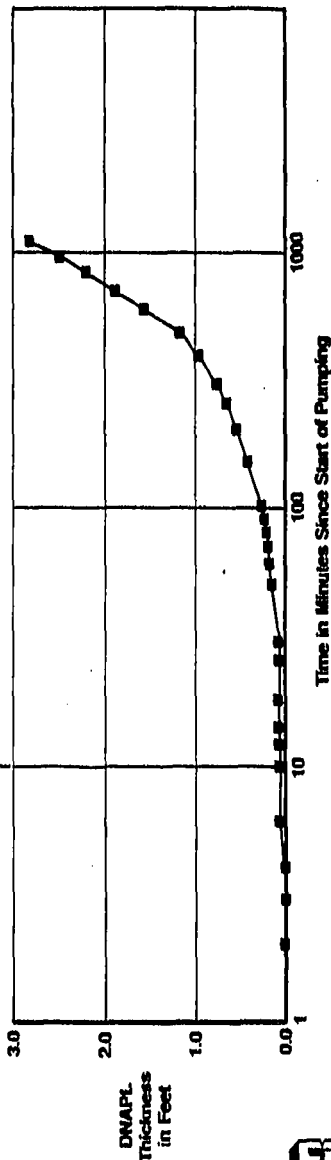
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**Figure 4-22**  
**Well 3-1**  
**Drawdown vs. DNAPL Accumulation**



KEY

▲ Drawdown in Feet, Well B  
 ■ DNAPL Thickness in Feet



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1 to 3 gpm reduced the static water level in Well 3-I by nearly forty feet. Recharge of DNAPL was measured to be 0.10 inches in 50 minutes and was steadily increasing. To maintain a static water level the pumping rate was reduced to 0.3 gpm one hour into the test. This resulted in a reduced rate of drawdown. Field observation of pump discharge indicated that DNAPL was not being removed during pumping. This may be a result of the use of low pumping rate and having the pump intake within the cased portion of the well. Reduced pumping efficiency, created by the build-up of silt behind the discharge control valve, resulted in a reduction of the pumping rate to 0.2 and 0.15 gpm. The water level in the well continued to drop and at 800 minutes measured 42.5 feet below the top of the casing. At this time the pumping rate remained between 0.2 - 0.15 gpm and the DNAPL measured 2.2 feet. At 1140 minutes (end of the test) the pumping level dropped to nearly fifty feet, requiring the pump intake to be lowered.

The submersible pump failed 1140 minutes into the test. The accumulation of DNAPL in Well 3-I continued after pumping ceased with 0.24 feet additional DNAPL accumulating in 8.9 hours. A total of 0.34 feet additional DNAPL had accumulated in 3-I three days after pumping had stopped. The well had not returned to static conditions and water levels were approximately fifteen feet below pre-test levels. One week later water level recovery continued and no additional measurable DNAPL accumulation was noted.

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#### 4.2.5.3 Long-Term Pump Test

A steady accumulation of DNAPL was measured in Well 5-S over the course of the long-term pump test (Figure 4-23). The initial DNAPL level was 0.3 feet and by the end of the test 0.93 feet of DNAPL had accumulated.

The pump was set 3-feet off the bottom of the well. This is well within the open interval of the well. It is likely that additional DNAPL would have accumulated if the submersible pump had been raised inside the well casing.

#### 4.2.5.4 Discussion of Results

From the testing conducted, DNAPL could not be induced to enter a well if only the small quantities of DNAPL present were purged. Therefore, a simple gravity-based recovery system would not result in the effective DNAPL recovery in the wells tested, or likely any well, on-site.

The testing indicates that the lowering of the hydrostatic head above the DNAPL enhances recovery of DNAPL. This is thought to be the result of the following:

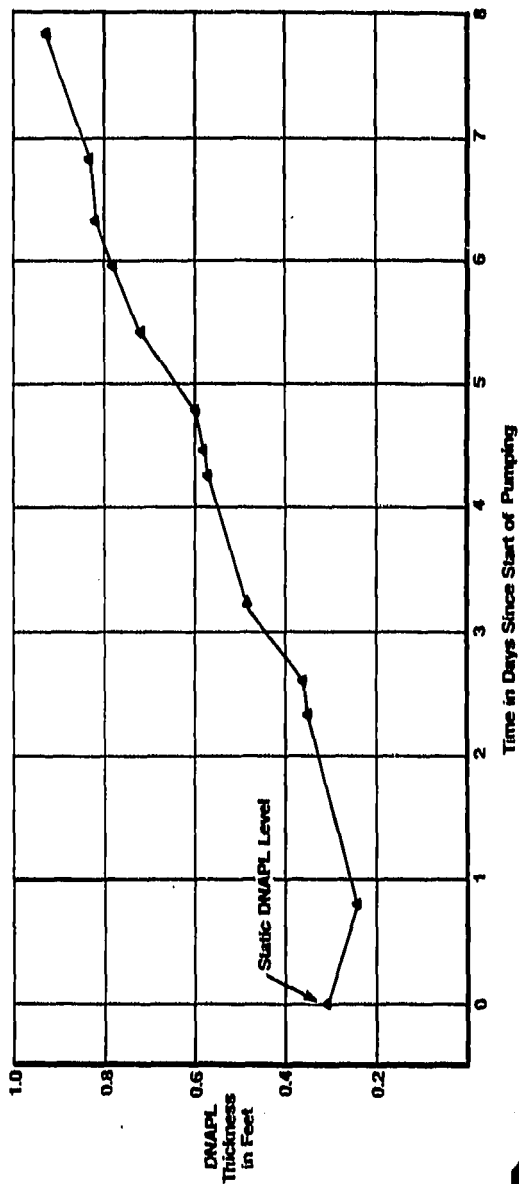
- Stimulation of ground water flow through secondary porosity features, particularly fractures, induces the flow of DNAPL into the borehole; and
- The reduction of the hydrostatic head within the well results in the upconing of DNAPL, an effect seen in other DNAPL recovery investigations.



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**Figure 4-23**  
**DNAPL Accumulation During**  
**Well 5-S**  
**Long Term Pump Test**



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The relative importance of either of these explanations for the accumulation of DNAPL in the well is difficult to assess as both are contributing factors.

In fractured bedrock, the movement of water takes place much more readily through secondary porosity features; hence, these features are controlling factors of the local hydrogeology. Because DNAPL has greater density (1.125 to 1.30 gm/cm<sup>3</sup>) and higher viscosity (3-7 cps) than water, secondary porosity features are also likely to be important for DNAPL movement through the bedrock.

The amount of upconing and therefore the degree of DNAPL recovery will be dependent on its availability in the aquifer. The amount of available DNAPL is related to both the amount of DNAPL present and the controlling permeability within the formation and interconnection to the borehole. The amount of DNAPL present in the fractured bedrock aquifer and the permeability or transmissivity of the aquifer to yield DNAPL is difficult, if not impossible, to calculate. The volume of DNAPL present would depend on the saturation of DNAPL into the primary porosity, frequency of fractures in the bedrock, dimensions of individual fractures and pores, and the horizontal and vertical extent of DNAPL. All of these variables would be difficult to approximate in a fractured bedrock aquifer.

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#### 4.2.6 Ground Water Quality

##### 4.2.6.1 Organic Compounds

The concentration of HSL inorganic and organic compounds detected in ground water samples taken from the newly installed bedrock wells and EPA installed overburden wells are presented in Table 4-7. In all wells, 1,2,3-trichloropropane was the organic compound found most frequently and at the highest concentration. Other volatile organic compounds commonly detected at elevated concentrations include: total xylenes, toluene, and Cis-1,3-dichloropropene.

HSL semi-volatile organic compounds were detected in 16 wells, 15 of the bedrock wells and only one of the unconsolidated wells. However, the presence of semi-volatile compounds was quantitatively confirmed in only 8 of the 16 wells. Concentrations of these semi-volatile compounds were less than 1 percent of the total HSL organic compound fraction. Nitrobenzene and 1,2,4-trichlorobenzene were present in the highest concentrations. No HSL organic compounds were detected in background well MW-1. The presence of PCBs and pesticides was not confirmed in any of the wells.

Since 1,2,3-trichloropropane was the most commonly detected compound in the ground water samples and the major component of the DNAPL, it serves as a good tracer for determining contaminant migration of site-related compounds. Isoconcentration maps have been constructed (Figures 4-24 through 4-26) which show the distribution of 1,2,3-trichloropropane in the bedrock monitoring wells. These maps have been developed using the concentrations

TABLE 4-7.  
TYPSON'S SITE  
GASOLINE WATER SAMPLE RESULTS  
HEAVY METALLIC CONSTITUENTS  
(All values are in mg/L)

CONSTITUENT	1	2-B	2-C	2-D	2-E	2-F	2-G	2-H	2-I	2-J	2-K	2-L	2-M	2-N	2-O	2-P	2-Q	2-R	2-S	2-T	2-U	2-V	2-W	2-X	2-Y	2-Z
Aluminum																										
Antimony																										
Arsenic																										
Barium	0.6	0.2	0.1	0.4	0.011	0.3 J	1.1	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	
Beryllium																										
Cadmium																										
Chromium																										
Cobalt																										
Copper																										
Iron																										
Lead		0.2 B		0.25 B	2	0.04 B	8.1	0.03 J																		2.4
Manganese																										
Mercury	0.02	0.3	0.03	3.84	0.002	0.28	0.27	0.03 B	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.47	
Nickel																										
Selenium																										
Silver																										
Thallium																										
Tin																										
Vanadium																										
Zinc	0.02 B	0.05 B	0.07 B	0.04 B	0.04 B	0.03 B	0.03 B	0.03 B	0.03 B	0.03 B	0.03 B	0.03 B	0.03 B	0.03 B	0.03 B	0.03 B	0.03 B	0.03 B	0.03 B	0.03 B	0.03 B	0.03 B	0.03 B	0.03 B	0.03 B	

CONSTITUENT	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Aluminum																									
Antimony																									
Arsenic																									
Barium																									
Beryllium																									
Cadmium																									
Chromium																									
Cobalt																									
Copper																									
Iron																									
Lead																									
Manganese																									
Mercury	0.01 J																								
Nickel																									
Selenium																									
Silver																									
Thallium																									
Tin																									
Vanadium																									
Zinc																									

Qualifier Codes:  
B - This result is of questionable significance since the constituent was also detected in Month 4  
J - This result should be considered a questionable estimate

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TABLE 4-7. (continued)  
TYSON'S SITE  
GROUND WATER SAMPLE RESULTS  
HEAVY METALLIC CONSTITUENTS  
(MU values in  $\mu\text{g/L}$ )

CONSTITUENT	8-0	8-5	8-1	8-3	8-5	8-6	10-0	10-30	11-5	11-12
Aluminum	0.2 B		0.1 B					0.2 B		
Antimony										
Arsenic										
Barium		0.4	2.1	3		0.1	0.016	3	0.3	0.2
Beryllium										
Cadmium										
Chromium										
Cobalt				0.03				0.01		
Copper										
Iron		1.2			13.2					
Lead					7.36				0.06	
Manganese		0.05	0.02							
Mercury										
Nickel										
Selenium										
Silver										
Thallium								0.03		
Tin										
Vanadium										
Zinc		0.01 B	0.01 B	0.02 B			0.02 B			

CONSTITUENT	11-0	12-5	12-6	12-7	8-0	8-2	8-4	ERT-1 (M)	ERT-1 (M)	ERT-2
Aluminum		1.1	0.1 B	0.03 M	0.08 M	0.07 M	---			
Antimony				0.001 M	0.002 M	0.001 M	---			
Arsenic				0.008 B	0.005 M	0.001 M	---			
Barium	0.2	0.3		0.2	0.06 J	0.04 J	---	0.2	0.1	0.1
Beryllium							---			
Cadmium	0.01				0.0002 M	0.001 M	---			
Chromium					0.002 M	0.002 M	---			
Copper				0.005 M	0.005 M	0.02 M	---			
Iron		0.49 J		0.0005 M	0.002 M	0.003 M	---			
Lead				24.2	0.04 B	0.05 B	---			
Manganese		0.01 J		8.34	0.001 M	1.46	---	0.03		
Mercury					0.36		---			
Nickel							---			
Selenium							---			
Silver							---			
Thallium							---			
Tin					0.002 M	0.003 M	---			
Vanadium					0.04 B	0.02 B	---			
Zinc					0.02 J	0.03 J	---	0.03 B	0.01 B	0.02 B

Qualifier Codes:

1 - This result is of questionable qualitative significance since this constituent was also detected in blank(s)  
2 - This result is of questionable qualitative significance since this constituent was also detected in blank(s)  
B - NOT TESTED

AR300208

TABLE 4-7 (continued)  
TYSON'S SITE  
GROUND WATER SAMPLE RESULTS  
HEC ORGANIC COMPOUNDS  
concentrations in µg/L

COMPOUND	1	2-S	2-I	3-S	3-I	3-D	4-S	4-I	4-D	5-S	5-I
<b>VOLATILES</b>											
1,2,3-Trichloropropane				360	810	0.87	22	3.4	22	230	1.7
Methylene Chloride				0.8 B	0.2 B	0.02 B	0.04 B	0.004 B	0.04 B		0.003 B
Acetone	0.005 B		0.1 B	7 B	1.1 B	0.13 B	0.06 B	0.04 B	0.07 B		0.002 B
1,1-Dichloroethane					0.3				0.04 J		
trans-1,2-Dichloroethane											
Chloroform				0.5 B	0.5		0.04 B	0.006 B			
2-Butanone					0.3 B		0.02 B				
1,2-Dichloropropane				1	1.3		0.03 J	0.003 J	0.07	1.1	
Trichloroethane				0.9	1		0.07				
Benzene						1.2	0.22		0.59	1.4	0.008
cis-1,3-Dichloropropene				18	4.9	0.02 J					
4-Methyl-2-pentanone				2.1	31 J	0.051		0.002 J	0.05	3.5	0.005
Tetrachloroethane				32	2			0.008 B		2.1	
Toluene				2.4	8.8	0.031		0.006	0.04 J	0.6	
Chlorobenzene				64	40	0.25		0.011 B	0.03 B	41	
1,1,1-Trichloroethane											
<b>SEMI-VOLATILES</b>											
Aniline			1.6	1.6 J	0.1 J						
Phenol			2.5 J	2.5 J							
4-Methylphenol			1.2 J	1.2 J							
2,4-Dimethylphenol			0.3 J	0.3 J							
2-Methylphenol			0.3 J	0.3 J							
Benzoic acid											
1,2-Dichlorobenzene				0.8 J	0.4 J					0.4	
1,4-Dichlorobenzene				0.3 J	2.5 J						
Hexachlorocyclopentadiene											
N-Tert-butylphenol				0.5 J	0.2 J	0.06 J		0.01		0.1	
1,2,4-Trichlorobenzene				0.2 B				0.01 B		0.1 B	
Di-tert-butyl pthalate				0.08 B				0.01 B			
Bis(2-ethylhexyl)phthalate	0.03 B								0.006 B		
Dibutyl phthalate			0.04 B								0.02 B

Qualifier Codes:  
B: This result is of questionable qualitative significance since this compound/constituent was detected in blank(s) at similar concentrations.  
J: This result should be considered a quantitative estimate.

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TABLE 4-7 (continued)  
TYSON'S SITE  
GROUND WATER SAMPLE RESULTS  
HSL ORGANIC COMPOUNDS  
concentrations in mg/L

COMPOUND	E-0	E-3	E-1	E-0	T-3	T-1	T-0	E-3	E-1	E-0	E-3
<b>VOLATILES</b>											
1,2,3-Trichloropropane	0.09	800	1200	55	0.23 J	0.78	0.19	3.8	3.8	7.7	0.004 J
Methylene Chloride	0.02 B	0.5 B					0.007 B				0.01 B
Acetone	0.04 B	3 B		0.03 B	0.01 B	0.006 B	0.02 B				
1,1-Dichloroethane				0.009							
trans-1,2-Dichloroethene											
Chloroform				0.01 B							
2-Butanone	0.08 B	1 B									
1,2-Dichloropropane											
Trichloroethene	0.2	1.3	1.3	0.056							
Benzene	1.2	1.1	1.1	0.042							
cis-1,3-Dichloropropene	14	6.7	9.3	0.42						1.1	
4-Methyl-2-pentanone		22		0.03		0.017	0.028		0.8		
Tetrachloroethene	0.53	1.4						0.06			
Toluene	0.17	41	18	0.76					0.2		
Chlorobenzene	0.07	2.3	1.4	0.079					1.2		
Ethylbenzene	0.73	9	3.7	0.27					0.2		
Total Styrenes	4.9	54	22	1.8			0.003 B		3.8		
<b>SEMI-VOLATILES</b>											
Aniline											
Phenol											
4-Methylphenol											
2,4-Dimethylphenol											
2-Methylphenol											
Benzoic acid											
1,2-Dichlorobenzene	0.006 J		1	0.01							
1,4-Dichlorobenzene											
Nitrobenzene											
N-Nitrosodiphenylamine		4	2	0.03							
1,2,4-Trichlorobenzene											
Di-n-butyl phthalate			5	0.08							
Bis(2-ethylhexyl)phthalate				0.03 B							
Dimethyl phthalate	0.006 B				0.04 B	0.02 B	0.005 B		0.3 B		0.03 B

Qualifier Codes:  
B: This result is of questionable qualitative significance since it's compound/constituent was detected in blank(s) at similar concentrations.  
J: This result should be considered a quantitative estimate.

AR300210

TABLE 4-7 (continued)  
TYSON'S SITE  
GROUND WATER SAMPLE RESULTS  
HSL ORGANIC COMPOUNDS  
Concentrations in µg/L

COMPOUND	8-I	8-D	10-S	10-I	10-D	10-ED	11-S	11-I	11-D	12-S	12-D
<b>VOLATILES</b>											
1,2,3-Trichloropropane			2.7				98.0	220	20		0.017
Methylene Chloride	0.007 B	0.004 B	0.006 B				0.5 B				0.012 B
Acetone	0.02 B	0.17 B	0.04 B	1 B			1 B	17 B			0.02 B
1,1-Dichloroethane			0.019				0.7				
trans-1,2-Dichloroethene			0.13							0.062	
Chloroform				0.6			0.8				
2-Butanone		0.005 B									0.01 B
1,2-Dichloropropane			0.051	1.9	2		1.6				
Trichloroethene			0.022				1.7			1.4	
Benzene			0.014	24	0.02	0.27	8.1	18	12		
cis-1,3-Dichloropropene	0.014	0.011	0.03				7				
4-Methyl-2-pentanone			0.009				0.9		0.08		
Tetrachloroethene			0.08	1.1			21	3.3	0.79		
Toluene			0.048				1.5		0.09		
Chlorobenzene			0.05	0.7			3.9	1.1	0.29		
Ethylbenzene			0.23	4.2	1.7	0.009 B	23	7.3	1.9		
Total xylenes											
<b>SEMIVOLATILES</b>											
Aniline											
Phenol	0.005 J					0.2 J					
4-Methylphenol											
2,4-Dimethylphenol											
2-Methylphenol											
Benzoic acid	0.04 J	0.01 J						0.1	0.02		
1,2-Dichlorobenzene											
1,4-Dichlorobenzene											
Nitrobenzene											
4-Nitroaniline							3.5	0.1	0.02		
1,2,4-Trichlorobenzene											
Di-n-butyl phthalate							0.6	0.31	0.05		
Di(2-ethylhexyl)phthalate											
Di-n-octyl phthalate											
Di-n-decyl phthalate											
Di-n-dodecyl phthalate											
Di-n-tetradecyl phthalate											
Di-n-hexadecyl phthalate											
Di-n-octadecyl phthalate											
Di-n-eicosyl phthalate											
Di-n-docosyl phthalate											
Di-n-tetracosyl phthalate											
Di-n-hexacosyl phthalate											
Di-n-octacosyl phthalate											
Di-n-triacontyl phthalate											
Di-n-pentacosyl phthalate											
Di-n-heptacosyl phthalate											
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Di-n-unicosyl phthalate											
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Di-n-unicosyl phthalate											
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Di-n-pentacosyl phthalate											
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Di-n-unicosyl phthalate											
Di-n-triacontyl phthalate											
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Di-n-pentacosyl phthalate											
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Di-n-nonacosyl phthalate											
Di-n-unicosyl phthalate											
Di-n-triacontyl phthalate											
Di-n-tetracosyl phthalate											
Di-n-pentacosyl phthalate											
Di-n-heptacosyl phthalate											
Di-n-nonacosyl phthalate											
Di-n-unicosyl phthalate				</							





## TABLE 4-7 (continued)

COMPOUND	1	2-S	2-I	3-S	3-I	3-D	4-S	4-I	4-D	5-S	5-I
Aldrin											
Beta BHC											
Endosulfan I	0.00001 NC										
Endosulfan II				0.0006 NC							
Endosulfan sulfate										0.00020 NC	
Gamma BHC - Lindane											
Dieldrin				0.00003 NC						0.00010 NC	

COMPOUND	5-D	5-S	6-I	6-D	7-S	7-I	7-D	8-S	8-I	8-D	9-S
Aldrin											
Beta BHC	0.00007 NC										
Endosulfan I											
Endosulfan II											
Endosulfan sulfate											
Gamma BHC - Lindane	0.0002 NC		0.00019 NC								
Dieldrin											

COMPOUND	9-I	9-D	10-S	10-I	10-D	11-S	11-I	11-D	12-S	12-D
Aldrin										
Beta BHC										
Endosulfan I										
Endosulfan II										
Endosulfan sulfate										
Gamma BHC - Lindane										
Dieldrin										

COMPOUND	9-I	9-S	10-S	10-I	10-D	11-S	11-I	11-D	12-S	12-I	12-D
Aldrin											
Beta BHC											
Endosulfan I											
Endosulfan II											
Endosulfan sulfate											
Gamma BHC - Lindane											
Dieldrin											

COMPOUND	9-I	9-S	10-S	10-I	10-D	11-S	11-I	11-D	12-S	12-I	12-D
Aldrin											
Beta BHC											
Endosulfan I											
Endosulfan II											
Endosulfan sulfate											
Gamma BHC - Lindane											
Dieldrin											

COMPOUND	9-I	9-S	10-S	10-I	10-D	11-S	11-I	11-D	12-S	12-I	12-D
Aldrin											
Beta BHC											
Endosulfan I											
Endosulfan II											
Endosulfan sulfate											
Gamma BHC - Lindane											
Dieldrin											

COMPOUND	9-I	9-S	10-S	10-I	10-D	11-S	11-I	11-D	12-S	12-I	12-D
Aldrin											
Beta BHC											
Endosulfan I											
Endosulfan II											
Endosulfan sulfate											
Gamma BHC - Lindane											
Dieldrin											

COMPOUND	9-I	9-S	10-S	10-I	10-D	11-S	11-I	11-D	12-S	12-I	12-D
Aldrin											
Beta BHC											
Endosulfan I											
Endosulfan II											
Endosulfan sulfate											
Gamma BHC - Lindane											
Dieldrin											

COMPOUND	9-I	9-S	10-S	10-I	10-D	11-S	11-I	11-D	12-S	12-I	12-D
Aldrin											
Beta BHC											
Endosulfan I											
Endosulfan II											
Endosulfan sulfate											
Gamma BHC - Lindane											
Dieldrin											

COMPOUND	9-I	9-S	10-S	10-I	10-D	11-S	11-I	11-D	12-S	12-I	12-D
Aldrin											
Beta BHC											
Endosulfan I											
Endosulfan II											
Endosulfan sulfate											
Gamma BHC - Lindane											
Dieldrin											

COMPOUND	9-I	9-S	10-S	10-I	10-D	11-S	11-I	11-D	12-S	12-I	12-D
Aldrin											
Beta BHC											
Endosulfan I											
Endosulfan II											
Endosulfan sulfate											
Gamma BHC - Lindane											
Dieldrin											

COMPOUND	9-I	9-S	10-S	10-I	10-D	11-S	11-I	11-D	12-S	12-I	12-D
Aldrin											
Beta BHC											
Endosulfan I											
Endosulfan II											
Endosulfan sulfate											
Gamma BHC - Lindane											
Dieldrin											

COMPOUND	9-I	9-S	10-S	10-I	10-D	11-S	11-I	11-D	12-S	12-I	12-D
Aldrin											
Beta BHC											
Endosulfan I											
Endosulfan II											
Endosulfan sulfate											
Gamma BHC - Lindane											
Dieldrin											

COMPOUND	9-I	9-S	10-S	10-I	10-D	11-S	11-I	11-D	12-S	12-I	12-D
Aldrin											
Beta BHC											
Endosulfan I											
Endosulfan II											
Endosulfan sulfate											
Gamma BHC - Lindane											
Dieldrin											

COMPOUND	9-I	9-S	10-S	10-I	10-D	11-S	11-I	11-D	12-S	12-I	12-D
Aldrin											
Beta BHC											
Endosulfan I											
Endosulfan II											
Endosulfan sulfate											
Gamma BHC - Lindane											
Dieldrin											

COMPOUND	9-I	9-S	10-S	10-I	10-D	11-S	11-I	11-D	12-S	12-I	12-D
Aldrin											
Beta BHC											
Endosulfan I											
Endosulfan II											
Endosulfan sulfate											
Gamma BHC - Lindane											
Dieldrin											

COMPOUND	9-I	9-S	10-S	10-I	10-D	11-S	11-I	11-D	12-S	12-I	12-D
Aldrin											
Beta BHC											
Endosulfan I											
Endosulfan II											
Endosulfan sulfate											
Gamma BHC - Lindane											
Dieldrin											

COMPOUND	9-I	9-S	10-S	10-I	10-D	11-S	11-I	11-D	12-S	12-I	12-D
Aldrin											
Beta BHC											
Endosulfan I											
Endosulfan II											
Endosulfan sulfate											
Gamma BHC - Lindane											
Dieldrin											

COMPOUND	9-I	9-S	10-S	10-I	10-D	11-S	11-I	11-D	12-S	12-I	12-D
Aldrin											
Beta BHC											
Endosulfan I											
Endosulfan II											
Endosulfan sulfate											
Gamma BHC - Lindane											
Dieldrin											

COMPOUND	9-I	9-S	10-S	10-I	10-D	11-S	11-I	11-D	12-S	12-I	12-D
Aldrin											
Beta BHC											
Endosulfan I											
Endosulfan II											
Endosulfan sulfate											
Gamma BHC - Lindane											
Dieldrin											

COMPOUND	9-I	9-S	10-S	10-I	10-D	11-S	11-I	11-D	12-S	12-I	12-D
Aldrin											
Beta BHC											
Endosulfan I											
Endosulfan II											
Endosulfan sulfate											
Gamma BHC - Lindane											
Dieldrin											

COMPOUND	9-I	9-S	10-S	10-I	10-D	11-S	11-I	11-D	12-S	12-I	12-D
Aldrin											
Beta BHC											
Endosulfan I											
Endosulfan II											
Endosulfan sulfate											
Gamma BHC - Lindane											
Dieldrin											

COMPOUND	9-I	9-S	10-S	10-I	10-D	11-S	11-I	11-D	12-S	12-I	12-D
Aldrin											
Beta BHC											
Endosulfan I											
Endosulfan II											
Endosulfan sulfate											
Gamma BHC - Lindane											
Dieldrin											

COMPOUND	9-I	9-S	10-S	10-I	10-D	11-S	11-I	11-D	12-S	12-I	12-D
Aldrin											
Beta BHC											
Endosulfan I											
Endosulfan II											
Endosulfan sulfate											
Gamma BHC - Lindane											
Dieldrin											

COMPOUND	9-I	9-S	10-S	10-I	10-D	11-S	11-I	11-D	12-S	12-I	12-D
Aldrin											
Beta BHC											
Endosulfan I											
Endosulfan II											
Endosulfan sulfate		</									

**Qualifier Code:**

TABLE-7 (continued)  
TYSON'S SITE  
GROUND WATER SAMPLE RESULTS  
TENTATIVELY IDENTIFIED COMPOUNDS  
(All concentrations are ESTIMATED and in mg/L)

COMPOUNDS	1	28	21	38	31	30	48
Total aliphatic hydrocarbons	0.079						0.68
Total chlorinated hydrocarbons		12.58	0.889	26.79			2.78
Total unknowns			81.7	21.13	3.21	0.513	1.75
Total unknown hydrocarbons							
Chlorinated propane							
Chloropropane							
Chloropropane					1200		
1-Propene							
3,5-Diethyl-1-propene							
Phenol, 4,4-(1-methylallylidene)bis			0.029				
Phenol, 2,6-Dichloro-			0.48				
n-Phenylacetamide				0.835			
Ethanone, 1-phenyl	0.0147		0.17				
Ethanone, 1,1-(1,3-phenylene)bis-			0.057				
Ethanone, 1,1-(1,4-phenylene)bis-			0.017				
Ethanone, 1-(4-(1-hydroxy-1-methylallyl)phenyl)-			0.023				
Oxalic acid				1.17			
3,3-Thiobis-1-propene							
1,2-Dichloro-1-propene							
1,3-Dichloro-1-propene							
2,3-Dichloro-1-propene					0.89	0.14	0.049
3,3-Dichloro-1-propene							
Chloromethylbenzene							
1,3,5-Trichlorobenzene							
1,1-dichlorobenzene							
1,4-Benzodioxin							
Benzene compound							
Benzenemethanol, alpha-methyl					0.13		
Tetrahydrofuran							
Dimethylnaphthalene compound							
1H-Indene compound							
Pentamethyl dihydroindene compound							
Propyl Anan							
3-Methylphenol				0.71			
2-Methyl-pyridine							
Hexahydro-2H-azepin-2-one							
2-Ethyl-1-hexanol							
1,7-Dihydro-6H-purin-6-one			0.18				0.88
(Chloromethyl)-oxirane				0.32	0.24		
Fatty alcohol							

B: This analyte was also found in the method blank.  
Blank = None detected.

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TABLE 4-7 (continued)  
TYSON'S SITE  
GROUND WATER SAMPLE RESULTS  
TENTATIVELY IDENTIFIED COMPOUNDS  
(All concentrations are ESTIMATED and in mg/L)

COMPOUNDS	41	4D	5B	5I	5D	5B
Total aliphatic hydrocarbons	0.399			0.048	0.139	
Total chlorinated hydrocarbons			30.46	0.587	0.125	316.8
Total unknowns	1.5	8.03	3.25	0.86	4.76	17.8
Total unknown hydrocarbons			2.42			
Chlorinated propene					0.55	
Chloropropene						
Chloropropene						
1-Propene						
3,3'-Oxybis-1-propene						
Phenol, 4,4'-(1-methylethylidene)bis						
Phenol, 2,6-Dichloro-						
n-Phenylacetamide						
Ethanone, 1-phenyl	0.027				0.048	
Ethanone, 1,1-(1,3-phenylene)bis-						
Ethanone, 1,1-(1,4-phenylene)bis-						
Ethanone, 1-(4-(1-hydroxy-1-methylethyl)phenyl)-						
Oxalic acid						
3,3'-Thiobis-1-propene						
1,2-Dichloro-1-propene						
1,3-Dichloro-1-propene						
2,3-Dichloro-1-propene		0.056	5.7		0.044	1.27
3,3-Dichloro-1-propene						
Chloromethylbenzene						1.6
1,3,5-Trichlorobenzene						
1,1-oxybisbenzene						
1,4-Benzodioxin						
Benzene compound					0.27	
Benzanemethanol, alpha-methyl						
Tetrahydrofuran						
Dimethylnaphthalene compound						
1H-Indene compound						
Pentamethyl dihydrolindene compound						
Propyl furan						
3-Methylphenol						
2-Methyl-pyridine						
Hexahydro-2H-azepin-2-one					0.041	
2-Ethyl-1-hexanol						
1,7-Dihydro-8H-purin-8-one						
(Chloromethyl)-oxirane						3.6
Fatty alcohol						

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TABLE 4-7 (continued)  
TYSON'S SITE  
GROUND WATER SAMPLE RESULTS  
TENTATIVELY IDENTIFIED COMPOUNDS  
(All concentrations are ESTIMATED and in mg/L)

COMPOUNDS	61	80	78	71	70
Total aliphatic hydrocarbons			0.011	0.011	0.055
Total chlorinated hydrocarbons	306.2	6.52			
Total unknowns	1.7	3.42	0.026	0.097	0.131
Total unknown hydrocarbons					0.084
Chlorinated propane					
Chloropropane		0.03			
Chloropropane	2				
1-Propene					
3,3'-Oxybis-1-propene					
Phenol, 4,4'-(1-methylethylidene)bis					
Phenol, 2,6-Dichloro-					
n-Phenylacetamide					
Ethanone, 1-phenyl		0.114			0.051
Ethanone, 1,1-(1,3-phenylene)bis-					
Ethanone, 1,1-(1,4-phenylene)bis-		0.954			
Ethanone, 1-(4-(1-hydroxy-1-methylethyl)phenyl)-					
Oxanoic acid					
3,3-Thiobis-1-propene					
1,2-Dichloro-1-propene					
1,3-Dichloro-1-propene					
2,3-Dichloro-1-propene	13	0.084			
3,3-Dichloro-1-propene					
Chloromethylbenzene	0.6				
1,3,5-Trichlorobenzene	2				
1,1-Oxybisbenzene		0.085			
1,4-Benzodioxin					
Benzene compound					
Benzenemethanol, alpha-methyl					
Tetrahydrofuran					
Dimethylnaphthalene compound					
14-Indene compound					
Perimethyl dihydroindene compound					
Propyl furan					
3-Methylphenol					
2-Methyl-pyridine					
Hexahydro-2h-azepin-2-one					
2-Ethyl-1-hexanol					
1,7-Dihydro-8h-purin-6-one					
(Chloromethyl)-oxirane					
Fatty alcohol					

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TABLE 4-7 (continued)  
TYSON'S SITE  
GROUND WATER SAMPLE RESULTS  
TENTATIVELY IDENTIFIED COMPOUNDS  
(All concentrations are ESTIMATED and in mg/L)

COMPOUNDS	88	81	8D	85	81	8D
Total aliphatic hydrocarbons					0.025	0.187
Total chlorinated hydrocarbons	1.57	28.4	4.44			
Total unknowns	0.082	0.97		0.039	0.038	0.257
Total unknown hydrocarbons						
Chlorinated propene						
Chloropropene						
Chloropropene						
1-Propene						
3,3'-Oxybis-1-propene						
Phenol, 4,4'-(1-methylallylidene)bis						
Phenol, 2,5-Dichloro-						
n-Phenylacetamide						
Ethanone, 1-phenyl					0.019	0.018
Ethanone, 1,1-(1,3-phenylene)bis-						
Ethanone, 1,1-(1,4-phenylene)bis-						
Ethanone, 1-(4-(1-hydroxy-1-methylallyl)phenyl)-						
Oxaloic acid						
3,3-Thiobis-1-propene						
1,2-Dichloro-1-propene						
1,3-Dichloro-1-propene						
2,3-Dichloro-1-propene			0.17			
3,3-Dichloro-1-propene						
Chloromethylbenzene						
1,3,5-Trichlorobenzene			0.12			
1,1-oxybisbenzene						
1,4-Benzodioxin						
Benzene compound						
Benzene compound, alpha-methyl						
Tetrahydrofuran						
Dimethylnaphthalene compound						
1H-Indene compound						
Pentamethyl dihydroindene compound						
Propyl Auran						
3-Methylphenol						
2-Methyl-pyridine						
Hexahydro-2h-azepin-2-one						
2-Ethyl-1-hexanol					0.012	
1,7-Dihydro-8h-purin-6-one						
(Chloromethyl)-oxirane						
Fatty alcohol						

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TABLE 4-7 (continued)  
TYSON'S SITE  
GROUND WATER SAMPLE RESULTS  
TENTATIVELY IDENTIFIED COMPOUNDS  
(All concentrations are ESTIMATED and in mg/L)

COMPOUNDS	108	101	100	10XD	118
Total aliphatic hydrocarbons				12.02	
Total chlorinated hydrocarbons		58.7	30.28	857	278.3
Total unknowns	1.74	0.75		18.87	6.03
Total unknown hydrocarbons					
Chlorinated propane					
Chloropropane					
Chloropropane			0.8		
1-Propene					
3,3'-Oxybis-1-propene					
Phenol, 4,4'-(1-methylallyl)bis					
Phenol, 2,5-Dichloro-					
n-Phenylacetamide	0.015				
Ethanone, 1-phenyl					
Ethanone, 1,1-(1,3-phenylene)bis-					
Ethanone, 1,1-(1,4-phenylene)bis-					
Ethanone, 1-(4-(1-hydroxy-1-methylallyl)phenyl)-					
Oxanolic acid					
3,3-Thiobis-1-propene	0.023				
1,2-Dichloro-1-propene	0.72				
1,3-Dichloro-1-propene					1.1
2,3-Dichloro-1-propene	0.077	2.7	1.4		
3,3-Dichloro-1-propene		0.18			
Chloromethylbenzene					
1,3,5-Trichlorobenzene					
1,1-oxybisbenzene					
1,4-Benzodioxin					
Benzene compound					
Benzenemethanol, alpha-methyl					
Tetrahydrofuran					
Dimethylnaphthalene compound				2	
1H-Indene compound				0.57	
Pentamethyl dihydroindane compound				2.8	
Propyl furan					
3-Methylphenol					
3-Methylpyridine					
Hexahydro-2H-azepin-2-one					
2-Ethyl-1-hexanol					
1,7-Dihydro-8H-purin-6-one					
(Chloromethyl)-oxirane					1.7
Fatty alcohol					

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TABLE 4-7 (continued)  
TYSON'S SITE  
GROUND WATER SAMPLE RESULTS  
TENTATIVELY IDENTIFIED COMPOUNDS  
(All concentrations are ESTIMATED and in mg/L)

COMPOUNDS	111	110	128	120	B-4	HUB-3
Total aliphatic hydrocarbons			0.013 B	0.28		
Total chlorinated hydrocarbons	82.2	0.344				
Total unknowns	0.57	2.45			8.1	
Total unknown hydrocarbons						
Chlorinated propene						
Chloropropene						
Chloropropene						
1-Propene						
3,3'-Oxybis-1-propene						
Phenol, 4,4'-(1-methylethylidene)bis						
Phenol, 2,5-Dichloro-						
n-Phenylacetamide						
Ethanone, 1-phenyl	0.31	0.022				
Ethanone, 1,1-(1,3-phenylene)bis-						
Ethanone, 1,1-(1,4-phenylene)bis-						
Ethanone, 1-(4-(1-hydroxy-1-methylethyl)phenyl)-						
Oxetan-2-ol						
3,3'-Thiobis-1-propene						
1,2-Dichloro-1-propene						
1,3-Dichloro-1-propene	1.2	0.014				
2,3-Dichloro-1-propene	0.18					
3,3-Dichloro-1-propene	0.28					
Chloromethylbenzene						
1,3,5-Trichlorobenzene		0.013				
1,1-dicyclopentadiene						
1,4-Benzodioxin		0.012				
Benzene compound						
Benzene compound, alpha-methyl						
Tetrahydrofuran						
Dimethylnaphthalene compound						
1H-Indene compound						
Pentamethyl dihydroindene compound						
Propyl furan					1.5	
2-Methylphenol	0.35					
2-Methylpyridine					12	
Hexahydro-2H-azepin-2-one						
2-Ethyl-1-hexanol						
1,7-Dihydro-8H-purin-6-one	1.4					
(Chloromethyl)-oxirane						
Fatty alcohol				0.12		

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TABLE 4-7(continued)  
TYSON'S SITE  
GROUND WATER SAMPLE RESULTS  
TENTATIVELY IDENTIFIED COMPOUNDS  
(All concentrations are ESTIMATED and in mg/L)

COMPOUNDS	NUS-4	NUS-5	NUS-7	001	002	004
Total aliphatic hydrocarbons						
Total chlorinated hydrocarbons						
Total unknowns			0.289	0.085	0.239	3.3
Total unknown hydrocarbons						
Chlorinated propene						
Chloropropene			0.04		0.03	
Chloropropene						
1-Propene			0.05		0.04	
3,3'-Oxybis-1-propene			0.01			
Phenol, 4,4'-(1-methylallylidene)bis						
Phenol, 2,6-Dichloro-						
n-Phenylacetamide						
Ethanone, 1-phenyl						
Ethanone, 1,1-(1,3-phenylene)bis-						
Ethanone, 1,1-(1,4-phenylene)bis-						
Ethanone, 1-(4-(1-hydroxy-1-methylallyl)phenyl)-						
Oxalic acid						
3,3-Thiodibis-1-propene						
1,2-Dichloro-1-propene						
1,3-Dichloro-1-propene						
2,3-Dichloro-1-propene						
3,3-Dichloro-1-propene			0.014			
Chloromethylbenzene						
1,3,5-Trichlorobenzene						
1,1-dibenzene						
1,4-Benzodioxin						
Benzene compound						
Benzenemethanol, alpha-methyl						
Tetrahydrofuran	0.01					
Dimethylnaphthalene compound						
1H-Indene compound						
Pentamethyl dihydroindene compound						
Propyl furan						
3-Methylphenol						
2-Methyl-pyridine						
Hexahydro-2H-azepin-2-one						
2-Ethyl-1-hexanol						
1,7-Dihydro-8H-purin-6-one						
(Chloromethyl)-oxirane						
Fatty alcohol						

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TABLE 4-7e(continued)  
TYSON'S SITE  
GROUND WATER SAMPLE RESULTS  
TENTATIVELY IDENTIFIED COMPOUNDS  
(All concentrations are ESTIMATED and in mg/L)

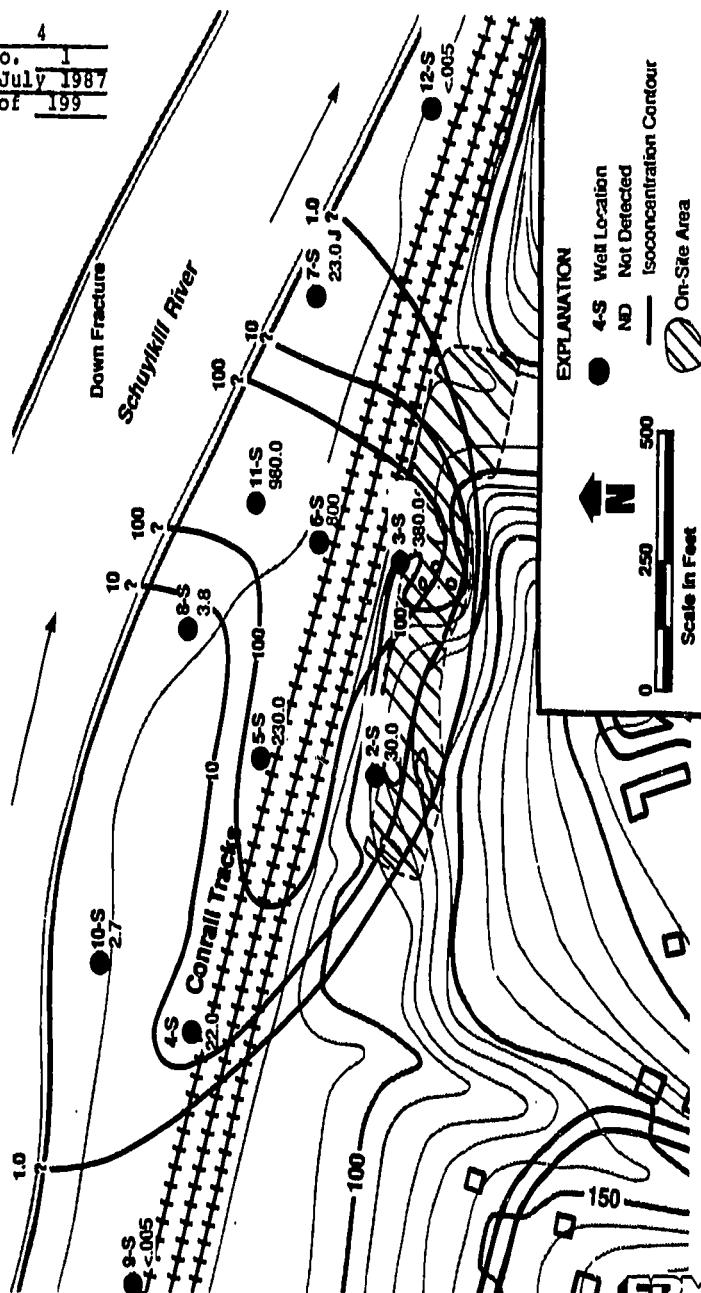
COMPOUNDS	ERT- (eh)	ERT- (dp)	ERT-2
Total aliphatic hydrocarbons			0.013
Total chlorinated hydrocarbons		0.51	
Total unknowns	7.25	2.84	0.035
Total unknown hydrocarbons	0.206	0.124	
Chlorinated propene			
Chloropropene			
Chloropropene			
1-Propene			
3,3'-Oxybis-1-propene			
Phenol, 4,4'-(1-methylethylidene)bis-			
Phenol, 2,6-Dichloro-			
n-Phenylacetamide			
Ethanone, 1-phenyl			
Ethanone, 1,1'-(1,3-phenylene)bis-			
Ethanone, 1,1'-(1,4-phenylene)bis-			
Ethanone, 1-(4-(1-hydroxy-1-methylethyl)phenyl)-			
Octanoic acid			
3,3'-Tris(bis-1-propene)			
1,2-Dichloro-1-propene			
1,3-Dichloro-1-propene			
2,3-Dichloro-1-propene			
3,3-Dichloro-1-propene			
Chloromethylbenzene			
1,3,5-Trichlorobenzene			
1,1-oxybisbenzene			
1,4-Benzodioxin			
Benzene compound			
Benzene methanol, alpha-methyl			
Tetrahydrofuran			
Dimethylnaphthalene compound			
1H-Indene compound			
Pentamethyl dihydroindene compound			
Propyl furan			
3-Methylphenol			
2-Methyl-pyridine			
Hexahydro-2H-szepin-2-one		0.018	0.045
2-Ethyl-1-hexanol			
1,7-Dihydro-8H-purin-6-one			
(Chloromethyl)-oxirane			
Fatty alcohol			

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**Figure 4-24**  
**Isoconcentration Map of 1,2,3-Trichloropropane**  
**in Shallow Wells (in mg/l)**  
**Tyson's Site**

Down Dip

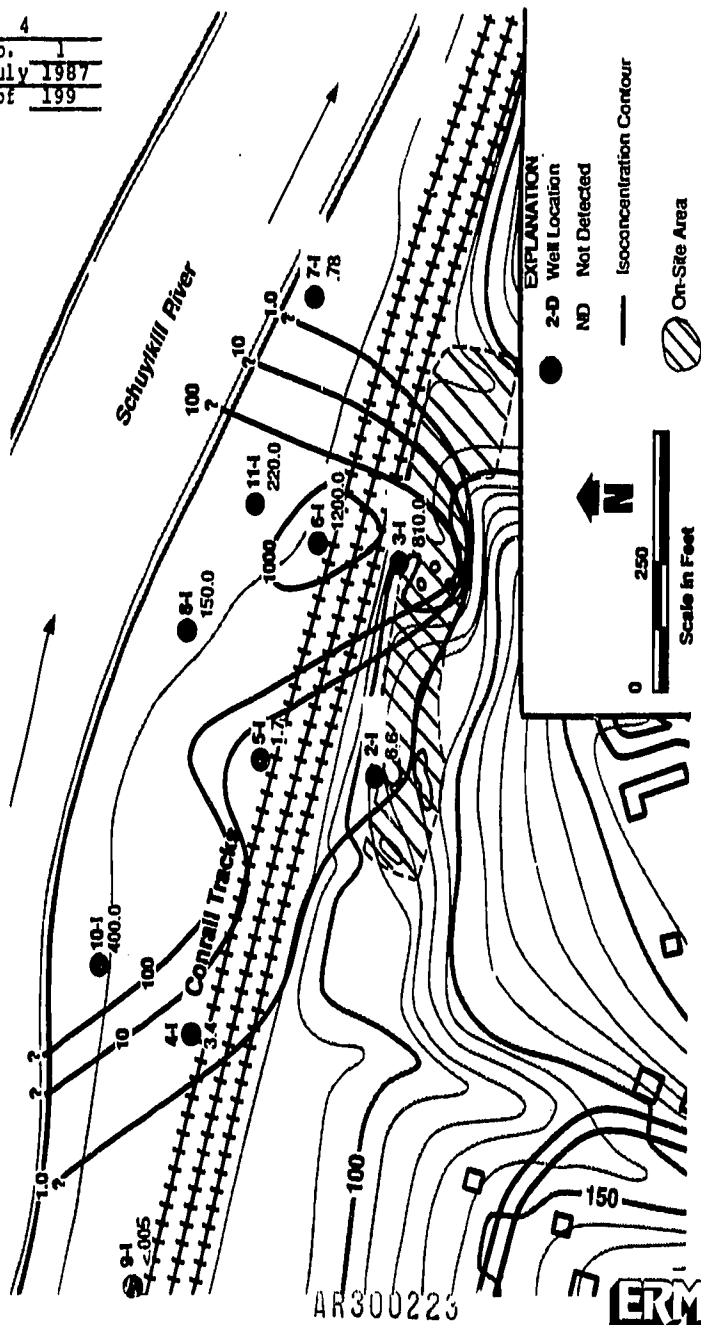


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**Figure 4-25**  
**Isoconcentration Map of 1,2,3-Trichloropropane**  
**in Intermediate Wells (in mg/l)**  
**Tyson's Site**





of the compounds detected in the ground water and knowledge of the site hydrogeologic conditions. 1,2,3-trichloropropane was found in concentrations greater than 100 mg/l in eight of the shallow and intermediate wells immediately north and west of the former lagoon area (Well Nests 2, 3, 4, 5, 6, 8, 9, 10, and 11). It was also found at concentrations ranging from 20 to 100 mg/l at four deep wells (4, 6, 10, and 11) and the extra deep well (10-XD). To the extreme east and west of the site (Well Nests 9 and 12), 1,2,3-trichloropropane was detected in a single well (12-D) at a concentration of 0.017 mg/l. The distribution of 1,2,3-trichloropropane, as shown by these results and Figures 4-24 through 4-26, indicates that the movement of this compound (and, therefore, the contaminant plume) is in two dominant directions:

- directly down dip (northwest) of the former lagoons, and
- along a zone of concentrated fracturing to the north and northeast of the eastern lagoon area.

The movement of the plumes in these directions would be expected given the site's geology, the physical nature of the DNAPL, and the down dip movement of the DNAPL along weathered bedding planes and through fracture zones.

Samples from wells installed by EPA in the unconsolidated deposits within the former lagoon area contain 1,2,3-trichloropropane in concentrations ranging from 82 mg/l to 690 mg/l. South of the railroad tracks to the east and west of

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the former lagoon (Figure 4-22), 1,2,3-trichloropropane concentrations ranged from 2.3 mg/l to 0.03 mg/l and none detected at ERT-2. The wells sampled on the floodplain which were completed in the unconsolidated deposits contain up to 0.73 mg/l of 1,2,3-trichloropropane.

Total xylenes and toluene were the second and third most abundant organic compounds detected in all wells. Their overall distribution was similar to 1,2,3-trichloropropane, as shown on Figures 4-28 through 4-30, and 4-31 and 4-32, respectively.

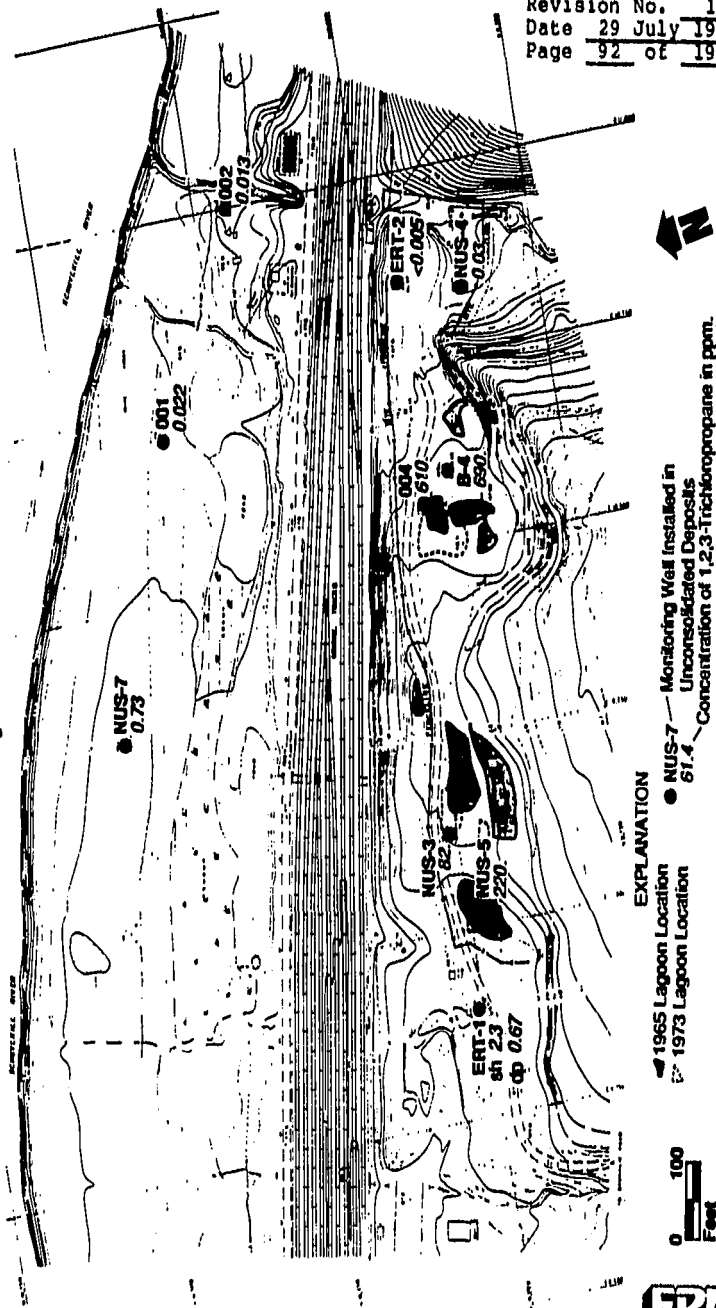
Tentatively identified organic compounds are presented in Table 4-27. At least one tentatively identified organic compound was detected in each of the bedrock monitoring wells, except well 12-S. The distribution and concentration of these compounds reflected that of 1,2,3-trichloropropane. Well Nests 2, 3, 5, 6, and 11 had the highest concentration and greatest number of tentatively identified compounds and are located down dip and immediately north of the former lagoon area.

Tentatively identified compounds were detected in nine out of eleven wells installed in the unconsolidated deposits. As with the HSL organic compounds, the highest concentrations were detected in Wells B-4 and 004 installed in the eastern lagoon area. The two wells in which tentatively identified compounds were not detected (NUS-3, NUS-5) are located in the western lagoon area.

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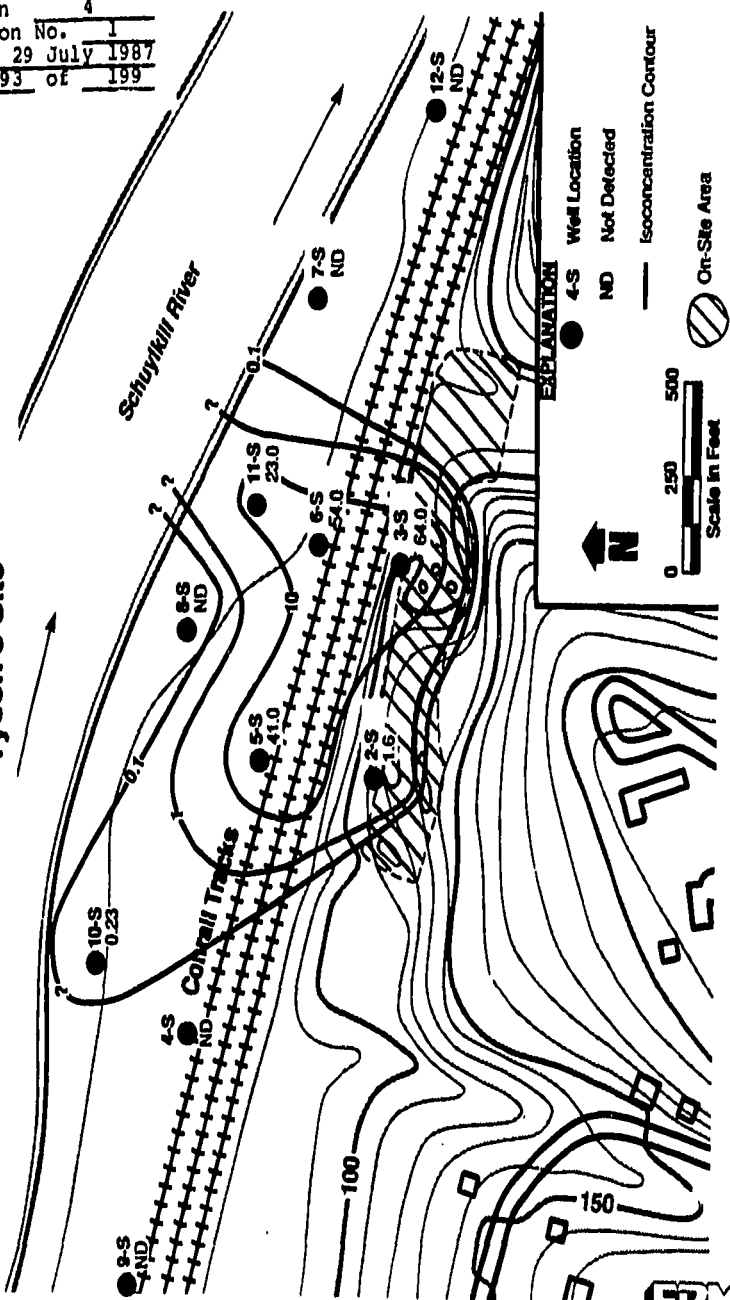
**Figure 4-27**  
**Concentration of 1,2,3-Trichloropropane in Wells**  
**Installed in Unconsolidated Deposits (in mg/l)**  
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**Figure 4-28**  
**Isoconcentration Map of Total Xylenes**  
**in Shallow Wells (in mg/l)**  
**Tyson's Site**

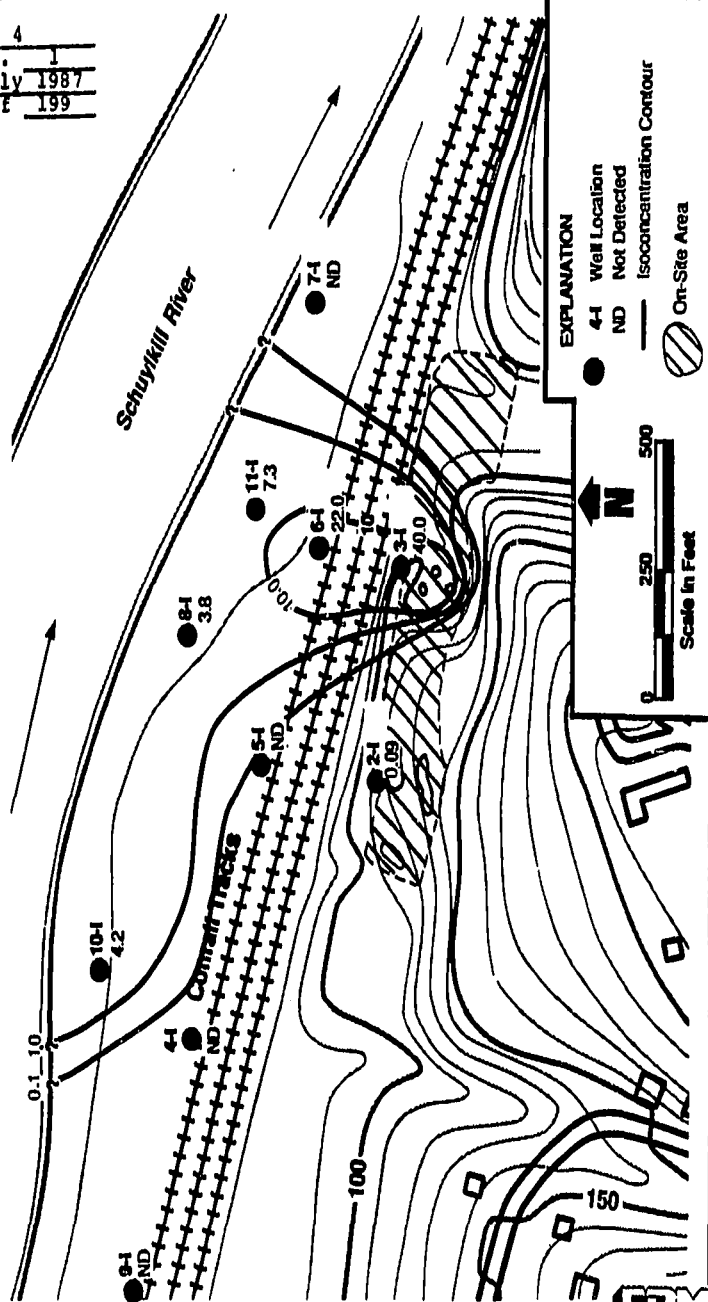


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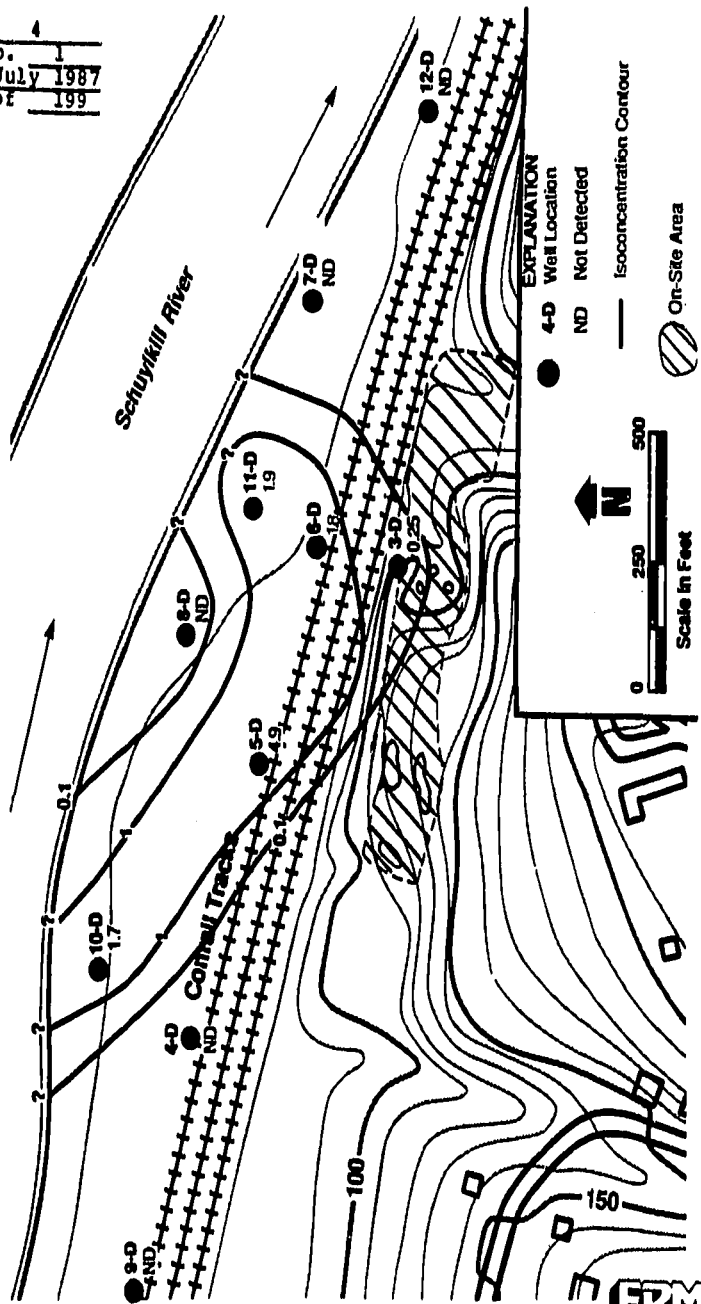
**Figure 4-29**  
**Isoconcentration Map of Total Xylenes**  
**in Intermediate Wells (in mg/l)**  
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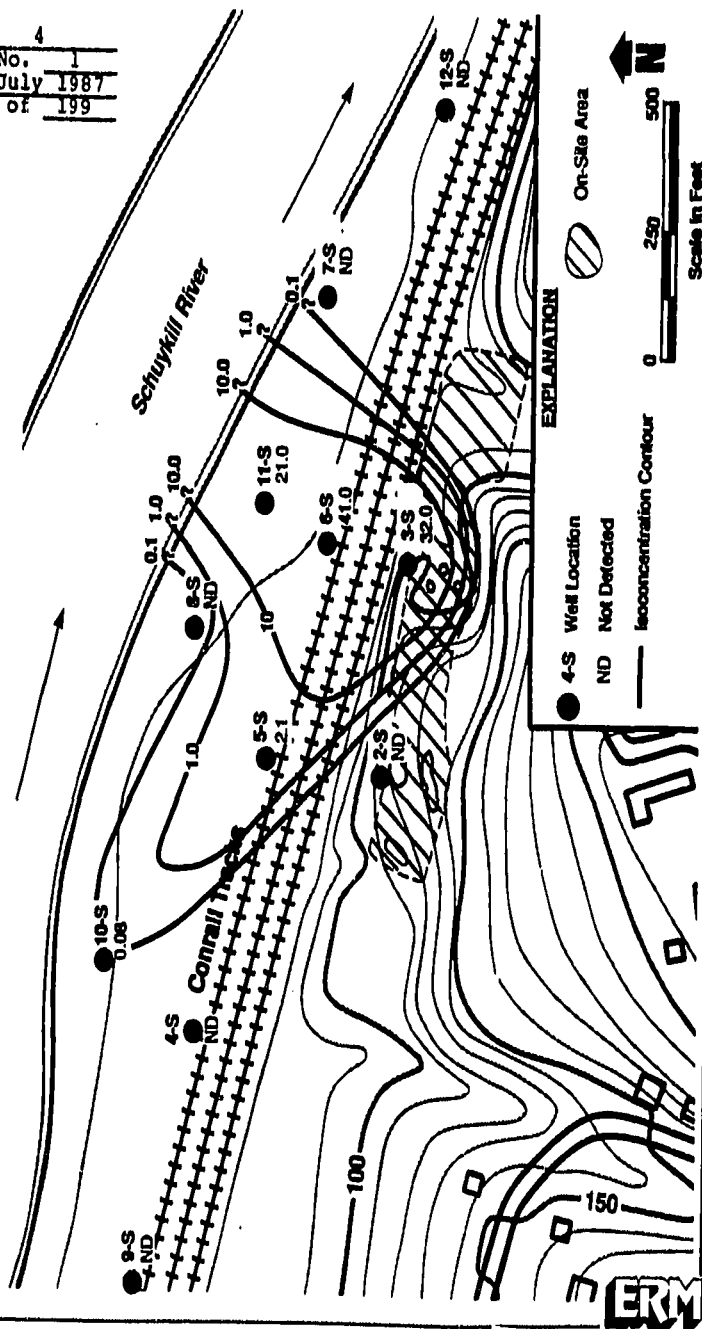
**Figure 4-30**  
**Isoconcentration Map of Total Xylenes**  
**in Deep Wells (in mg/l)**  
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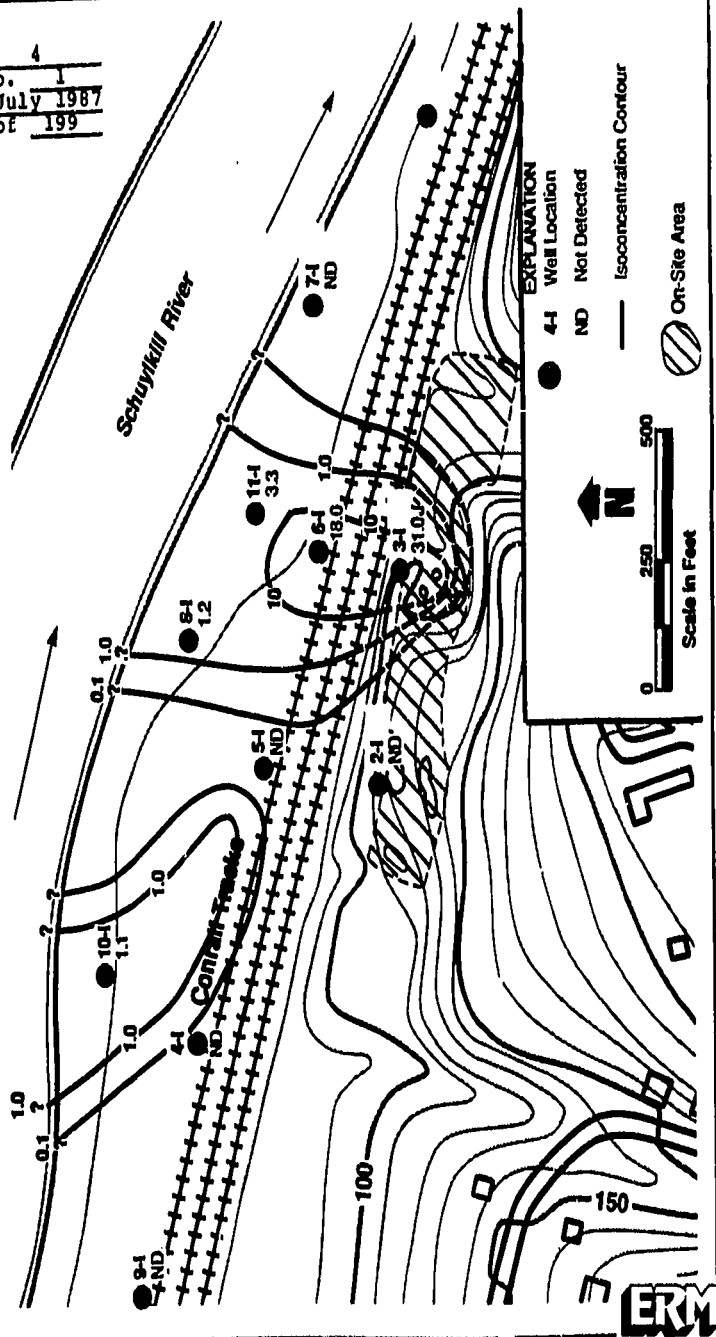
**Figure 4-31**  
**Isoconcentration Map of Toluene**  
**in Shallow Wells (in mg/l)**  
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**Figure 4-32**  
**Isoconcentration Map of Toluene**  
**in Intermediate Wells (in mg/l)**  
**Tyson's Site**



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#### 4.2.6.2 Inorganic Constituents

The concentration of HSL inorganic constituents detected in ground water samples collected from the newly installed bedrock wells and EPA wells installed in the unconsolidated deposits are presented in Table 4-7. The HSL inorganic constituents found in the greatest concentrations were aluminum, barium, iron, and manganese. These constituents have the following distributions:

- Aluminum concentrations for Wells 3-D and 5-D were 9.3 and 1.1 mg/l, respectively;
- Barium concentrations were less than 1.0 mg/l except at five wells (9-I, 9-D, 10-XD, 3-D, and 6-S) where the concentrations ranged from 1.1 to 3.0 mg/l;
- Iron concentrations were less than 1.0 mg/l, except at six wells (3-S, 3-D, 5-S, 9-S, 10-S, and NUS-7) the concentration ranged from 1.20 to 24.2 mg/l; and
- Manganese concentrations were less than 0.50 mg/l in all but five wells. In these wells (3-S, 6-S, 10-S, 002, and NUS-7) it ranged from 1.18 mg/l to 6.34 mg/l.

The highest concentrations of these four constituents often occur at the same wells or well nests (Well Nests 3, 9, 10 and NUS-7), but they do not coincide with the distribution of the highest concentration of organic compounds.

The concentrations of other minor HSL inorganic constituents analyzed were generally much less than the four previously described constituents, with concentrations being less than 0.03 mg/l. These minor constituents were generally distributed in a similar manner as aluminum, barium, iron, and manganese.

#### 4.2.6.3 Field pH, Specific Conductance, and Temperature

Field pH, specific conductance, and temperature measurements for all wells sampled are presented in Table 4-8. As previously described in Section 3.2.2, difficulties were encountered with the measurement of pH due to problems with the pH probes. Therefore, the pH values are not thought to be representative of actual conditions.

Specific conductance varied widely from 156 to 5880 umhos/cm with a mean value of 655 umhos/cm, and most values below 1,000 umhos/cm. Temperature values ranged from 13.0°C to 17.0°C, except for one value of 8°C which likely is a result of measurement error.

#### 4.2.7 Source of Ground Water Contamination in the Deep Aquifer

There are currently three sources of ground water contamination in the deep aquifer: (1) the DNAPL within the bedrock aquifer, (2) DNAPL present in unsaturated bedrock immediately below the lagoons, and (3) the contaminated soils in the former lagoons. Because of the estimated quantity of DNAPL in the bedrock and its presence directly in the bedrock aquifer, the present

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TABLE 4-8  
FIELD MEASUREMENTS OF PH,  
SPECIFIC CONDUCTANCE AND TEMPERATURE

Well #	pH	specific conductance (unhos/cm) at 250C	Temp. (0C)
7S	6.8	NM	NM
1	5.8	238	15.2
7I	8.6	192	15
7D	6.5	357	15.5
9D	6.2	3960	15
9I	8.0	5880	15
9S	7.55	233	15.5
4I	8.7	185	14.0
4D	9.1	196	14.5
4S	8.8	210	16.0
5D	9.2	605	8.0
5I	8.6	156	15.0
11D	NM	960	13.5
11I	NM	388	14.5
11S	NM	321	15.5
6D	NM	321	15.5
6I	7.85	281	14.5
6S	6.70	738	14.5
10I	7.25	381	14.5
8D	6.9	201	14.0
8S	6.2	610	14.0
8I	6.85	329	14.0
10S	7.25	878	14.0
10D	10.54	475	13.5
5S	6.95	278	14.5
2S	6.85	186	15.5
2I	7.10	254	13.2
3S	7.30	1320	NM
3D	7.40	992	13.0
3I	6.95	462	14.5

NOTES

NM - Indicates that the parameter was not measured

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TABLE 4-8 (cont'd)  
FIELD MEASUREMENTS OF PH,  
SPECIFIC CONDUCTANCE AND TEMPERATURE

<u>Well #</u>	<u>pH</u>	<u>specific conductance (unhos/cm) at 25°C</u>	<u>Temp. (°C)</u>
NUS-7	6.3	332	15.5
002	6.3	278	17.0
001	5.75	187	16.5
NUS-5	NM	NM	NM
NUS-3	NM	NM	NM
B-4	NM	NM	NM
004	NM	NM	NM
ERT-2	5.7	150	15.0
NUS-4	NM	NM	NM
ERT-1(shallow)	5.2	235	15.5
ERT-1(deep)	6.2	204	NM

NOTES

NM - Indicates that the parameter was not measured

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contribution of the soils in the former lagoon area to the ground water contamination is negligible.

It is known that bulk liquid chemicals were disposed of at Tyson's Site directly into the unlined former lagoons. The lagoons were situated directly upon or within the sandstone bedrock and the sandstone near to the bedrock surface is known to be extensively fractured. It is not known what the level of liquids was in the lagoons during their operation, but it was almost certainly sufficient to overcome capillary forces and drive DNAPL chemicals down into the sandstone bedrock. DNAPL penetration would occur primarily through fractures and bedding plane partings in the sandstone but could also penetrate into coarse-grained permeable units in the sandstone, both in the unsaturated and saturated zones. The migration of DNAPL through the sandstone would be controlled by the orientation and interconnection of the fractures, and the orientation and extent of the coarse-grained beds.

Migration through the bedrock would continue until the volume of DNAPL which penetrated the bedrock was completely assimilated into the sandstone as residual along the fractures and within the coarse-grained beds, or the density-induced downward pressure gradient of the DNAPL was diminished to the extent that it would be counter-balanced by capillary resistance or relative permeability of the strata. A complete and detailed discussion of subsurface contamination by DNAPL chemicals at Tyson's Site is provided in Feenstra and Cherry (1986) and in Section 4.2 of this report.

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A simple conceptual model, as shown in Figure 4-33 can be used to evaluate the contribution of the soils in the former lagoon area and the DNAPL in bedrock, and hence the relative significance of each. Direct evaluation of ground water contamination by DNAPL involves uncertainties associated with the extent of the DNAPL. Therefore, the contaminant mass rates are evaluated first for the lagoon area and total ground water. The DNAPL contribution is then the difference between the lagoon mass loading rate and the total ground water mass loading rate. This evaluation was conducted using the four most prominent compounds found in both the lagoon area soils and ground water: 1,2,3-trichloropropane, xylene, toluene, and ethylbenzene.

#### Former Lagoon Area Mass Loading Rate

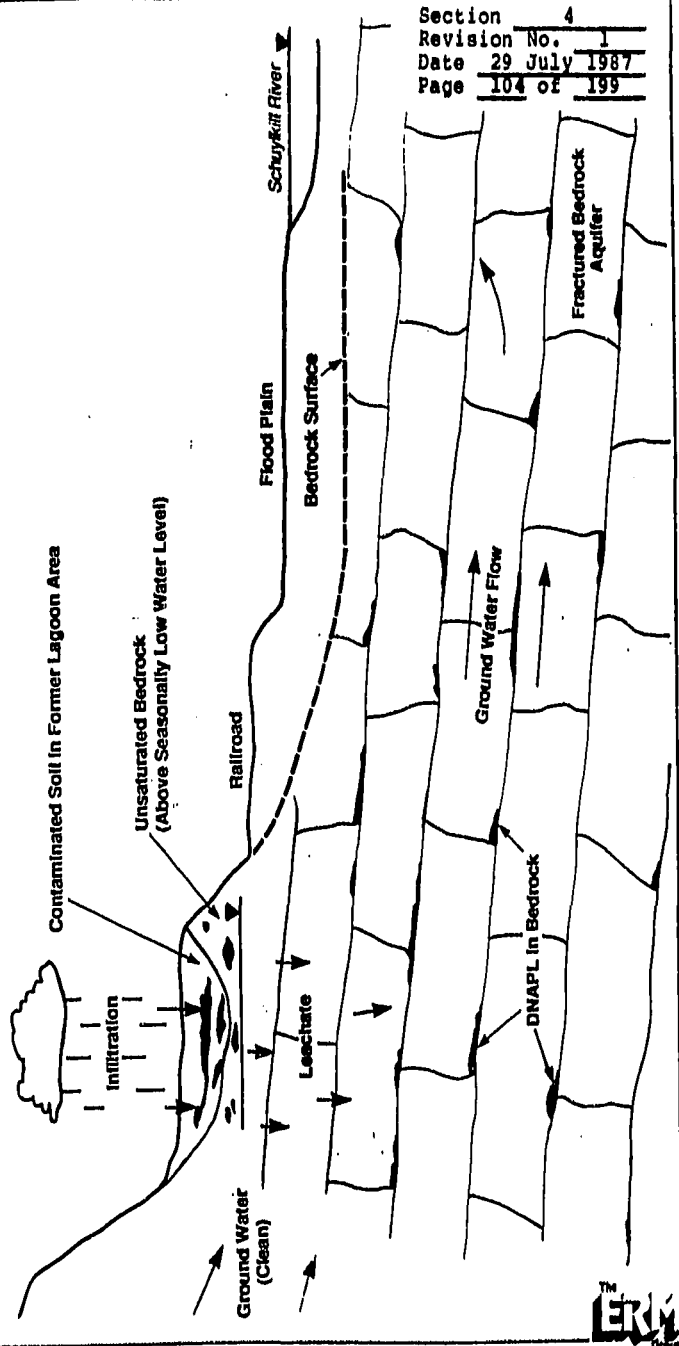
The contribution of contaminated soils in the former lagoon area can be determined utilizing the known concentrations of these compounds in those monitoring wells located within the surficial deposits of the former lagoons and infiltration rates based on the following assumptions:

- Under the annual equilibrium conditions, the volume of surface water infiltrating into the former lagoon area is identical to the volume of leachate generated.
- Concentrations of these organic compounds in the overburden monitoring wells is representative of the leachate infiltrating the bedrock.
- The entire volume of leachate generated enters the deep aquifer. Thus, the volume of surface water

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**Figure 4-33**  
**Conceptual Model of**  
**Ground Water Contamination Sources**



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infiltration is identical to the volume of leachate entering the deep aquifer.

The average concentrations for these four compounds in the overburden monitoring wells sampled and analyzed during the Off-Site RI are shown in Table 4-9.

The annual infiltration rate was estimated by comparing the site's conditions (soil, slope, vegetation, climate, etc.) with those of aquifers with known annual recharge. Walton (Groundwater Resources Evaluation 1970) presents a summary of recharge rates for a number of Illinois aquifers. The annual recharge rates for the areas with favorable infiltration conditions (e.g., sand/gravel deposits, and flat topography) vary from 5.4 inches to 10.2 inches or 15 percent to 29 percent of annual precipitation. Considering the relatively flat topography and silty sand in the former lagoon area, a conservative estimate of annual infiltration rates in the former lagoon area is about 25 percent of annual precipitation (45 inches), or 12 inches.

The surface area contributing to infiltration is the former lagoon area plus upslope highwall areas. The total surface area was determined to be 121,275 square feet. The corresponding annual infiltration is 121,275 cubic feet or 3.43 million liters. The annual mass loading rate from the lagoon source was computed as:

$$ML \text{ (mg/year)} = C_L \text{ (mg/l)} \times 3.43 \times 10^6 \text{ (l/year)} \text{ or}$$

$$ML \text{ (Kg/year)} = 3.43 C_L$$

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TABLE 4-9  
Effects of Former Lagoon and DNAPL Sources on Ground Water Contamination

Lagoon Area	1, 2, 3- Trichloropropane	Xylene	Toluene	Ethyl- benzene	Total
Leachate conc.* (ppm)	160.6	18.6	11.1	2.33	
Mass rate (kg/year)	551	63.8	38.1	7.99	660.9
Ground Water					
Mass rate (kg/year)	14,900	2,200	230	330	17,660
Contribution					
Contribution by lagoon area (%)	3.7	2.9	16.6	2.4	3.7
Contribution by DNAPL (%)	96.3	97.1	83.4	97.6	96.3

Note:

\* Average concentrations of these compounds in on-site overburden wells exhibiting site related contamination.

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where

ML = the mass loading rate from the lagoon source

$C_L$  = average concentration of a compound in monitoring wells completed in the surficial deposits in the former lagoon area

The contributions of the four compounds ranged from 551 kilograms per year for 1,2,3-trichloropropane to 7.99 kilograms per year for ethylbenzene (Table 4-9).

It should be recognized that DNAPL is also present in unsaturated bedrock immediately underlying the former lagoons. Water infiltrating through this zone will contact DNAPL and the concentrations of DNAPL constituents are expected to increase before the infiltrating water reaches saturated bedrock.

#### Rate of Dissolved Contaminant Transport

Calculations of the rate at which dissolved contaminants are transported by ground water flowing through the deep aquifer downgradient of the site were made by multiplying the rate of ground water flow (as described in Section 4.2.3.5) by the weighted average concentration of the dissolved contaminants.

The weighted average concentration of each dissolved contaminant within each transmissivity area was calculated by multiplying the observed concentration of that contaminant within a depth interval at a well nest location by the estimated transmissivity of the same depth interval at that well nest, and dividing this

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product by the sum of the total transmissivities at all wells nests within that area.

The contribution of each transmissivity area to rate of contaminant transport was calculated by multiplying the weighted average concentration for the area with the rate of ground water flow through the area. The sum of the transport rates for each area gave the total rate of transport. The results of these mass transport rate calculations for the four pertinent dissolved contaminants are shown on Table 4-9.

As shown on Table 4-9, the contributions of the four compounds range from 14,900 kg/year for 1,2,3-trichloropropane to 230 kg/year for toluene. Also note that these wastes represent the total mass rate from both the on-site lagoon soils and DNAPL sources within the bedrock.

#### Relative Contribution of Lagoon and DNAPL Sources

The contribution of the four principal compounds via each source along with the percentage contributed by the lagoons are also presented on Table 4-9. The percent contribution of each compound from the former lagoon also was calculated by :

$$\text{Percent contribution} = \frac{M_L \times 100}{\text{MGW}}$$

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where

$M_L$  = Mass rate from lagoon area, kg/yr.

MGW = Total mass rate by ground water downgradient of the site, kg/yr.

Calculated results vary from 2.4 percent for ethylbenzene to 16.6 percent for toluene. The overall contribution of these four organic constituents via the contaminated lagoon soils is only about 3.7 percent of the total contaminant mass in ground water. On the other hand, about 96.3 percent of the contamination in the deep aquifer results from the DNAPL present in the bedrock aquifer.

#### 4.2.8 Well Inventory

A total of 154 wells were identified within an approximate three mile radius of the site. A few of these wells are actually outside of this radius. Identified wells along with pertinent information, where available, have been listed and are found in Appendix N. The locations are shown in Plate 4.

Seventy-three of the identified wells are used as domestic or public water supplies, ten wells are used for industrial purposes, twenty-four wells are currently not in use, and six wells serve as monitoring wells. These latter wells are in the Norristown State Hospital well field. There was insufficient data to determine the use of the remaining thirty-three wells.

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#### 4.2.9 River Sediment and Water Sampling

##### Sediment

Sediment samples were collected in October 1986 from a total of ten (10) stations, including four stations in the river flow immediately adjacent to the site between the south bank and Barbadoes Island, three sampling sites in the river flow on the north side of Barbadoes Island, one station approximately at midstream of combined flow to the west of the island and one upstream station in the vicinity of the Route 441 bridge. The sampling stations are presented in Figure 3-3 and described in Section 3.2.7. River sediments consisted of fine, medium, and coarse sand with organic matter (clams, plant stocks, and leaves). On occasion, 1 to 2-inch clay and silt beds were observed. Sand sized clasts were composed of both quartz and coal. At the bottom of two sediment cores collected at Stations I and E, red weathered shale was observed. The extracted core was split into two samples, a surface and subsurface sample, at Stations B, C, D, and I. Logs of the sediment cores are included in Appendix E.

Table 4-10 presents a summary of the analytical results of the HSL volatile and semi-volatile organic analyses. HSL volatile compounds were detected in three of fourteen samples. 1,2,3-trichloropropane was detected in the three samples collected in the immediate vicinity of the site, Stations E (0.063 mg/kg), F (0.17 mg/kg), and J (0.006 mg/kg). The concentration reported at station J is an estimated value. 1,2,3-trichloropropane was not detected in sediments downriver of the site (Stations G and I) or in stations to the north of Barbadoes Island (B, C, D) or to the west (upstream), Stations A

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**TABLE 4-10**  
**TRYBON'S SITE**  
**Floodplain Acute Sediment Flows for**  
**HSL Organic Compounds**

Sample Number	C71 SMA A (Background)	C77 SMA B (14-27)	C78 SMA C (0-5)	C79 SMA D (5-24)	C81 SMA E (8-5)	C82 SMA F (5-24)	C83 SMA G (5-27)	C84 SMA H (5-27)	C85 SMA I (5-27)	C86 SMA J (5-27)	C87 SMA K (5-27)	C88 SMA L (5-27)	C89 SMA M (5-27)	C90 SMA N (5-27)	C91 SMA O (5-27)	C92 SMA P (5-27)	C93 SMA Q (5-27)	C94 SMA R (5-27)	C95 SMA S (5-27)	C96 SMA T (5-27)	C97 SMA U (5-27)	C98 SMA V (5-27)	C99 SMA W (5-27)	C100 SMA X (5-27)	C101 SMA Y (5-27)	C102 SMA Z (5-27)	C103 SMA AA (5-27)	C104 SMA AB (5-27)	C105 SMA AC (5-27)	C106 SMA AD (5-27)	C107 SMA AE (5-27)	C108 SMA AF (5-27)	C109 SMA AG (5-27)	C110 SMA AH (5-27)	C111 SMA AI (5-27)	C112 SMA AJ (5-27)	C113 SMA AK (5-27)	C114 SMA AL (5-27)	C115 SMA AM (5-27)	C116 SMA AN (5-27)	C117 SMA AO (5-27)	C118 SMA AP (5-27)	C119 SMA AQ (5-27)	C120 SMA AR (5-27)	C121 SMA AS (5-27)	C122 SMA AT (5-27)	C123 SMA AU (5-27)	C124 SMA AV (5-27)	C125 SMA AW (5-27)	C126 SMA AX (5-27)	C127 SMA AY (5-27)	C128 SMA AZ (5-27)	C129 SMA BA (5-27)	C130 SMA BB (5-27)	C131 SMA BC (5-27)	C132 SMA BD (5-27)	C133 SMA BE (5-27)	C134 SMA BF (5-27)	C135 SMA BG (5-27)	C136 SMA BH (5-27)	C137 SMA BI (5-27)	C138 SMA BJ (5-27)	C139 SMA BK (5-27)	C140 SMA BL (5-27)	C141 SMA BM (5-27)	C142 SMA BN (5-27)	C143 SMA BO (5-27)	C144 SMA BP (5-27)	C145 SMA BQ (5-27)	C146 SMA BR (5-27)	C147 SMA BS (5-27)	C148 SMA BT (5-27)	C149 SMA BU (5-27)	C150 SMA BV (5-27)	C151 SMA BW (5-27)	C152 SMA BX (5-27)	C153 SMA BY (5-27)	C154 SMA BZ (5-27)	C155 SMA CA (5-27)	C156 SMA CB (5-27)	C157 SMA CC (5-27)	C158 SMA CD (5-27)	C159 SMA CE (5-27)	C160 SMA CF (5-27)	C161 SMA CG (5-27)	C162 SMA CH (5-27)	C163 SMA CI (5-27)	C164 SMA CJ (5-27)	C165 SMA CK (5-27)	C166 SMA CL (5-27)	C167 SMA CM (5-27)	C168 SMA CN (5-27)	C169 SMA CO (5-27)	C170 SMA CP (5-27)	C171 SMA CQ (5-27)	C172 SMA CR (5-27)	C173 SMA CS (5-27)	C174 SMA CT (5-27)	C175 SMA CU (5-27)	C176 SMA CV (5-27)	C177 SMA CW (5-27)	C178 SMA CX (5-27)	C179 SMA CY (5-27)	C180 SMA CZ (5-27)	C181 SMA DA (5-27)	C182 SMA DB (5-27)	C183 SMA DC (5-27)	C184 SMA DD (5-27)	C185 SMA DE (5-27)	C186 SMA DF (5-27)	C187 SMA DG (5-27)	C188 SMA DH (5-27)	C189 SMA DI (5-27)	C190 SMA DJ (5-27)	C191 SMA DK (5-27)	C192 SMA DL (5-27)	C193 SMA DM (5-27)	C194 SMA DN (5-27)	C195 SMA DO (5-27)	C196 SMA DP (5-27)	C197 SMA DQ (5-27)	C198 SMA DR (5-27)	C199 SMA DS (5-27)	C200 SMA DT (5-27)	C201 SMA DU (5-27)	C202 SMA DV (5-27)	C203 SMA DW (5-27)	C204 SMA DX (5-27)	C205 SMA DY (5-27)	C206 SMA DZ (5-27)	C207 SMA EA (5-27)	C208 SMA EB (5-27)	C209 SMA EC (5-27)	C210 SMA ED (5-27)	C211 SMA EE (5-27)	C212 SMA EF (5-27)	C213 SMA EG (5-27)	C214 SMA EH (5-27)	C215 SMA EI (5-27)	C216 SMA EJ (5-27)	C217 SMA EK (5-27)	C218 SMA EL (5-27)	C219 SMA EM (5-27)	C220 SMA EN (5-27)	C221 SMA EO (5-27)	C222 SMA EP (5-27)	C223 SMA EQ (5-27)	C224 SMA ER (5-27)	C225 SMA ES (5-27)	C226 SMA ET (5-27)	C227 SMA EU (5-27)	C228 SMA EV (5-27)	C229 SMA EW (5-27)	C230 SMA EX (5-27)	C231 SMA EY (5-27)	C232 SMA EZ (5-27)	C233 SMA FA (5-27)	C234 SMA FB (5-27)	C235 SMA FC (5-27)	C236 SMA FD (5-27)	C237 SMA FE (5-27)	C238 SMA FG (5-27)	C239 SMA FH (5-27)	C240 SMA FI (5-27)	C241 SMA FJ (5-27)	C242 SMA FK (5-27)	C243 SMA FL (5-27)	C244 SMA FM (5-27)	C245 SMA FN (5-27)	C246 SMA FO (5-27)	C247 SMA FP (5-27)	C248 SMA FQ (5-27)	C249 SMA FR (5-27)	C250 SMA FS (5-27)	C251 SMA FT (5-27)	C252 SMA FU (5-27)	C253 SMA FV (5-27)	C254 SMA FW (5-27)	C255 SMA FX (5-27)	C256 SMA FY (5-27)	C257 SMA FZ (5-27)	C258 SMA GA (5-27)	C259 SMA GB (5-27)	C260 SMA GC (5-27)	C261 SMA GD (5-27)	C262 SMA GE (5-27)	C263 SMA GF (5-27)	C264 SMA GH (5-27)	C265 SMA GI (5-27)	C266 SMA GJ (5-27)	C267 SMA GK (5-27)	C268 SMA GL (5-27)	C269 SMA GM (5-27)	C270 SMA GN (5-27)	C271 SMA GO (5-27)	C272 SMA GP (5-27)	C273 SMA GQ (5-27)	C274 SMA GR (5-27)	C275 SMA GS (5-27)	C276 SMA GT (5-27)	C277 SMA GU (5-27)	C278 SMA GV (5-27)	C279 SMA GW (5-27)	C280 SMA GX (5-27)	C281 SMA GY
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**Datum reported by** EPA, Inc.

† - Estimated value  
B - The authors were not able to calculate the significance of the difference between the two groups

**Blank - name deleted**

**S - suspect value**  
**ALL ENR data has gone through a quality assurance review.**

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and H. Sediments from downriver Station F had detectable concentrations of eight other volatile organics.

A single observation of 1,2,4-trichlorobenzene (0.34 mg/kg) was made at Station F. The most commonly detected semi-volatile organic compounds in the sediments were a suite of polycyclic aromatic hydrocarbons (PAHs). PAHs were detected in six of fourteen samples ranging in total concentration from 0.46 mg/kg of benzo (a) pyrene, which was the only PAH detected at Station I, to 3.41-20.74 mg/kg in the five stations where a suite of PAHs were detected. The PAHs may be due to the presence of coal fines washed from upriver locations (coal storage piles along the river). As discussed in Section 4.7, PAHs were not found in the on-site soil and subsurface soil samples taken from the former lagoon areas.

Tables 4-11 and 4-12 provide the grain size and TOC analyses for the sediment samples taken from the Schuylkill River in April 1987. As expected from the description of the heterogeneity of the sediment in the river (both distribution and composition), the results of these analyses are quite variable.

#### Water

Analytical results for bottom water samples collected in the Schuylkill River during October 1986 are presented in Table 4-13. These samples were collected at sediment sampling stations A through I and analyzed for HSL volatile organic compounds and 1,2,3-trichloropropane. In addition, bottom water samples collected at station G were analyzed for HSL semi-volatile organics, pesticides/PCBs, and inorganic constituents. Samples

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TABLE 4-11  
 TYSON'S SITE  
 SCHUYLKILL RIVER SEDIMENT SAMPLES  
 GRAIN SIZE DISTRIBUTION  
 APRIL 22, 1987

LOCATION	% Retained on #4	% Retained on #10	% Retained on #40	% Retained on #200	% Through #200
Station C	15.2	3.9	66.8	13.8	0.3
Station E*	6.9	0.5	18.2	53.2	21.2
Station F	25.3	10.6	60.2	2.5	1.4
Station G	59.1	1.2	25.3	8.0	6.4
Station H	3.6	1.4	50.2	33.2	11.6
Station J	4.1	7.9	84.2	3.1	0.7

The following is a description of materials that passed through the #4 sieve.

Sample	Description
C	Shells, leaves and small stones
E	Stones
F	Shells and small stones
G	Shells, stones and pieces of glass
H	Shells, leaves and small stones
J	Shells

- \* Sample E contained two large clasts which were excluded from the sieve analyses above. These clast comprised 41.4% by weight of the sample.

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TABLE 4-12  
TYSON'S SITE  
SCHUYLKILL RIVER SEDIMENT SAMPLES  
APRIL, 1987

	Station C	Station E	Station F	Station G	Station H	Station J
Moisture % by wt.	41.6	59.8	21.3	53.2	58.5	27.4
TOC mg/kg as received	6900	8800	1800	11000	3800	2400
TOC mg/kg dry wt. basis	12000	22000	2300	24000	9200	3300

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TABLE 4-13  
TIDBOW'S SITE  
SCHWELDEL RIVER BOTTOM WATER RESULTS  
NHL INORGANIC CONSTITUENTS AND ORGANIC COMPOUNDS  
(Concentration in mg/L)

COMPOUND	Station A		Station B		Station C		Station D		Station E	
	Oct-86	Feb-87	Oct-86	Feb-87	Oct-86	Feb-87	Oct-86	Feb-87	Oct-86	Feb-87
<b>VOLATILES</b>										
ACETONE	0.008 B		0.01 B		0.07 B		0.007 B		0.008 B	
METHYLENE CHLORIDE			0.002 B		0.09 B				0.002 B	
TOLUENE					0.002 B					
TOTAL XYLENE										
2,3-DIBUTADIENE										
<b>INORGANIC COMPOUNDS</b>										
ALUMINUM (Filtered/Unfiltered)										
CHROMIUM										
COPPER										
IRON										
MANGANESE										
ZINC										
<b>SEMI-VOLATILE ORGANICS</b>										
<b>PCB'S/PESTICIDES</b>										
DOSE										

NOTES:

NAC Not analyzed

Blank sample: None detected

J : This result should be considered a qualitative estimate.

B : This result is of questionable qualitative significance since this compound/constituent was detected in blank(s) at similar concentrations.

1,2,3-Trichloropropane has been tested in each sample.

No values have been detected.

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TABLE 4-13 (continued)  
TYSON'S SITE  
SCHUTZELL RIVER BOTTOM WATER RESULTS  
HEAL INORGANIC CONSTITUENTS AND ORGANIC COMPOUNDS  
(Concentration in µg/l)

COMPOUND	Section E		Section G		Section H		Section I		Section J	
	Oct-86	Feb-87	Mar-87	Oct-86	Feb-87	Mar-87	Oct-86	Feb-87	Mar-87	Oct-86
VOLATILES										
ACETONE	0.018			0.18						
METHYLENECHLORIDE				0.003 B						
TOLUENE										
TOTAL XYLENE	0.007			0.005 J						
RSUTANONE	0.008 B									
INORGANIC COMPOUNDS										
ALUMINUM (Filtered)				0.5ND						
CHROMIUM				0.010/0.04						
COPPER				0.05ND						
IRON				0.86/0.1						
MANGANESE				0.130/0.11						
ZINC				0.090/0.08						
SEE VOLATILE ORGANICS										
PCB/SUPERCHBES										
NONE										

NOTES:

NAL: Not analyzed

Blank spurs: None detected

J: This result should be considered a qualitative estimate.

B: This result is of questionable qualitative significance since the compound/concentration was detected in blank(s) at similar concentration.

1,2,3-Trichloropropane has been tested in each sample.

No values have been detected.

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TABLE 4.13 (continued)  
TYPERS SITE  
SCHUTTELL WASTE TREATMENT PLANT REMAINS  
HEAVY METALS, VOLATILES AND ORGANIC COMPOUNDS  
(Concentration in mg/L)

COMPOUND	Station X			Station L		
	Oct-86	Feb-87	Mar-87	Oct-86	Feb-87	Mar-87
<b>VOLATILES</b>						
ACETONE						
CHLOROFORME						
ETHYLENE						
TOTAL NITRO						
2-ETHANONE						
<b>ORGANIC COMPOUNDS</b>						
ALUMINUM (Fluoride/Unfluor)						
CHROMIUM						
COPPER						
IRON						
MANGANESE						
ZINC						
<b>SEMI-VOLATILE ORGANICS</b>						
<b>PCB'S/PESTICIDES</b>						

NOTE:  
Mn Not analyzed  
NO and Ni not present: None detected  
J : Estimated value  
B : This sample was: also found in the method blank  
1,2,3-Trichloropropane has been tested in each sample.  
No values have been detected.

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collected for inorganic analyses were both filtered and unfiltered in order to characterize the dissolved and total metal concentrations, respectively.

Low levels of methylene chloride, acetone, 2-butanone, and toluene were detected in trip and/or laboratory blanks; therefore, the presence of these compounds is questionable and as such are not considered representative of water quality. The only organic compound quantitatively confirmed in these bottom water samples was xylene (0.007 mg/l) at station F. Inorganic constituents detected included aluminum, chromium, copper, iron, manganese, and zinc. Filtered (dissolved) and unfiltered (total) sample results were similar for zinc and manganese.

Additional bottom water samples were collected at stations A through I in February and March with station J sampled only in March. All samples were analyzed for HSL volatile organic compounds and 1,2,3-trichloropropane. In addition, bottom water samples collected at station G in February were analyzed for HSL semi-volatile organics and pesticides/PCBs. Samples collected at station G in March were analyzed for HSL volatile and semi-volatile organic compounds, pesticides/PCBs, 1,2,3-trichloropropane, and total inorganic constituents. The results of these analyses are also given on Table 4-13.

The presence of methylene chloride in a method blank during the analysis of March 1987 samples makes the presence of this compound in samples collected at stations A, H, I, and J in March 1987 qualitatively questionable. No organic compounds were detected at any of the sample stations during either February or March. Inorganic constituents detected at stations G and H

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during the March 1987 sampling include aluminum, iron, manganese, and zinc.

PA American Water Company personnel have collected samples of river water at the PA American Water Company intake (Plate 2) periodically from April 1985 and have supplied data for this report from April 1985 to January 1987. These samples were analyzed for priority pollutant pesticides, acid and base/neutral extractables, and volatile organic compounds. Bis-(2-ethylhexyl) phthalate was detected (0.06 mg/l) in the August 1986 sample and chloroform was detected (.001 mg/l) in the January 1987 sample. None of the other analyzed compounds were detected. Results are included in Appendix O.

The above described samples were all obtained and analyzed using methods which typically give detection limits of 1 ug/L. EPA collected and analyzed samples at the PA American Water Company intake at Norristown and the Philadelphia intakes at Belmont and Queen Lane (Plate 5) using methods with detection limits for 1,2,3-trichloropropane in the parts per trillion (ppt) range (Appendix Q). By these methods, ppt levels of 1,2,3-trichloropropane were detected at the 3 intakes. ERM collected river water samples at the PA American Water Company intake and upriver of the Tyson's Site in April 1987 to confirm the presence or absence of the trace levels of 1,2,3-trichloropropane reported by EPA. 1,2,3-trichloropropane was detected at .350 ug/l at the intake and an estimated concentration of .018 ug/l at the upriver location.

The confirmation of ppt level concentrations of 1,2,3-trichloropropane prompted an expanded river water sampling

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program. Water samples were collected further upriver and downriver of the Tyson's Site, as discussed in Section 3.2.7 and illustrated on Plate 5. Results of the sampling program (Table 4-14) revealed trace level concentrations of 1,2,3-trichloropropane from the PA American Water Company intake downriver to Bartram's Park. Similar concentrations were detected in both the river and treated water at all three intakes. Concentrations of 1,2,3-trichloropropane at the Linden Avenue sampling station along the Delaware River and the two stations upriver from the Norristown intake were below detection limits (10 ppt).

After confirmation of the ppt levels of 1,2,3-trichloropropane in the river water, additional water quality data was obtained from the Philadelphia Water Department for the Belmont and Queen Lane intakes. This data is also provided in Appendix O. Since 1979, the Philadelphia Water Department has been collecting samples of the raw and treated water at both intakes and analyzing for various organic compounds. These analyses were performed by gas chromatography (GC) techniques with detection limits as low as 100 parts per trillion (ppt). However, the data prior to June 1986 must be used cautiously since confirmatory techniques (i.e., GC-Mass Spectroscopy) were not historically performed. In fact, prior to July 1982 less sensitive analytical techniques were employed and these earlier data are of limited value in attempting to ascertain any historical pattern of organic compounds in the low ppt range.

Review of the data from the Philadelphia intakes shows that 1,2,3-trichloropropane is a consistently detected compound in the raw Schuylkill River water. The most often detected compounds in

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TABLE 4-14

TYSON'S SITE  
SCHUYLKILL RIVER RESULTS  
COMPOUND: 1,2,3-TRICHLOROPROPANE  
(concentration in ug/l)

LOCATION	River Pt. #1 Far Upstream	River Pt. #2 Station H	River Pt. #3 Norristown Raw	River Pt. #4 Norristown Treated	Queen Lane Raw	Queen Lane Treated
CONCENTRATION	BDL	BDL	0.210	0.430	0.170	0.190

LOCATION	Spring Mill	Belmont Raw	Belmont Treated	Bartrum Park	Linden Ave.
CONCENTRATION	0.310	0.160	0.130	0.100	BDL

BDL= Below detection limit

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the treated water at both intakes are TCP and the trihalomethanes. The trihalomethanes are most probably a result of chlorination. Table 4-15 shows the average annual concentrations of 1,2,3-trichloropropane and trihalomethanes in both the raw and treated water at the Queen Lane and Belmont Treatment Plants. Since it is the more representative, only the data since 1982 has been averaged and included on Table 4-15.

Review of all available data indicate that current water treatment practices have no effect on 1,2,3-trichloropropane at the three plants. Treatment generally consists of sand filtration and, rarely, activated carbon filtration (i.e., only when complaints of odors or taste necessitate). A description of the treatment at each of the three plants is provided in Appendix P. Because no substantial blending of water from other sources occurs, the sample data from each of the public water supplies are regarded as representative of the levels occurring in the distribution system and at the consumers' taps (no tap water samples have been collected).

#### River Piezometers

Water samples were collected from piezometers PZ-1 through PZ-5 and PZ-7 and PZ-8. Piezometer PZ-6 did not yield sufficient ground water for sampling purposes and sample PZ-0 was a trip blank. The samples were analyzed for HSL volatile organic compounds and 1,2,3-trichloropropane; results are presented in Table 4-16. Because of the low level presence of methylene chloride, acetone and toluene in the method blank, the presence of the first two compounds in each of the samples, and toluene in samples from piezometers 3 and 7, are qualitatively questionable.

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TABLE 4-16  
 TYSON'S SITE  
 SCHUYLKILL RIVER PIEZOMETER WATER SAMPLES  
 HSL ORGANIC COMPOUNDS  
 APRIL, 1987  
 (concentration in mg/L)

VOLATILES	PZ-1	PZ-2	PZ-3	PZ-4	PZ-5	PZ-7	PZ-8
Methylene chloride	0.003B	0.003B	0.003B	0.003B	0.003B	0.003B	0.003B
Acetone	0.03B	0.01B	0.04B	0.007B	0.02B	0.05B	0.02B
Carbon disulfide						0.003J	0.006
1,1-Dichloroethane					0.006		0.007
Trans-1,2-Dichloroethene					0.002J		
2-Butanone			0.007J				
Benzene					0.015		0.038
Toluene			0.003 B		0.019	0.002B	0.028
Chlorobenzene					0.003J		0.038
Ethylbenzene					0.005		0.020
Total xylenes					0.017		0.031

Qualifier codes:

B: This result is of questionable qualitative significance since this compound was detected in blanks(s) at similar concentrations.  
 J: This result should be considered a quantitative estimate.

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Volatile organic compounds were detected only in the samples from PZ-3, 5, 7, and 8. Carbon disulfide concentrations ranged from 0.006 mg/L to 0.013 mg/L and 1,1-dichloroethane concentrations did not exceed 0.007 mg/L. A trans-1,2,-dichloroethene concentration of 0.002 mg/L was quantitatively estimated in a sample from PZ-5. 2-butanone was estimated to be 0.007 mg/L in piezometer 3. Similarly, dilute concentrations of benzene, toluene, xylenes, chlorobenzene, and ethylbenzene were found in piezometers 5 and 8.

#### 4.3 Hillside Area

A total of nine soil samples were taken from the locations shown on Plate 7. For this investigation, the Hillside Area is defined as that area from just north of the security fence to the base of the bedrock outcrop which separates the former lagoon area from the railroad tracks. The purpose of this effort was to determine if the soils in these areas had been affected by overflow from the former lagoons or discharge from the bedrock outcrop observed on the hillside. The hillside area is comprised of soils of the Landsdale series. Because of the steepness of the hillside (15-35 percent slope), these soils are severely eroded. The erosion tends to concentrate sandstone pebbles and fragments on the soil surface. Typically these soils are shallow, with the substratum at depths of 10-18 inches (Smith, 1967).

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### Organic Compounds

Organic compounds were detected in four of the nine hillside soil samples (Table 4-17). Sample SS017 contained three volatile compounds including trichloroethene (0.02 mg/kg), tetrachloroethene (0.03 mg/kg), and 1,2,3-trichloropropane (0.20 mg/kg). One semi-volatile compound, 2,4-dimethylphenol, was also detected in sample SS017 at 0.63 mg/kg. Sample SS020 contained 1,2,3-trichloropropane at 0.25 mg/kg, which was the highest level detected in the hillside soils, and naphthalene at 0.23 mg/kg. Sample SS023 contained 0.0085 mg/kg of tetrachloroethene. Sample SS024 contained seven semi-volatile compounds including 5 PAHs with a total PAH concentration of 2.7 mg/kg and two substituted phenols with a total concentration of 1.15 mg/kg.

A total of 10 tentatively identified compounds were quantitatively estimated in the hillside soils. Compounds detected in the method blank do not appear in this table.

### Inorganic Constituents

Concentrations of inorganic constituents in soil samples taken from the hillside area are presented in Table 4-17. With the exceptions of copper in sample SS022 and selenium in sample SS020, all constituents were found to be well within or below the reported typical ranges of inorganic constituents in eastern United States soils (Table 4-18). Elevated levels of these constituents were found in only two of the samples obtained from the hillside area. Consequently, this contamination is believed to be localized. The localized nature of the elevated concentrations when combined with the fact that both copper and

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TABLE 4-17  
TYSON'S SITE  
HELIXIDE AREA SOIL RESULTS  
ORGANIC COMPOUNDS  
mg/kg, dry weight basis

Sample Number Date sampled Parameter	HS SS 017 A	HS SS 018 A	HS SS 019 A	HS SS 020 A	HS SS 021 A	HS SS 022 A	HS SS 023 A	HS SS 024 A	HS SS 025 A
<b>VOLATILES</b>									
Methylene chloride	0.0298	0.0439	0.0318	0.0358	0.0158	0.0378	0.00748	0.0108	0.028
Acetone	0.0258	0.178	0.068	0.0428	0.0328	0.0548	0.0328	0.0338	0.0338
Chloroform		0.0068							
Trichloroethene	0.021								
Tetrachloroethene	0.030								
Toluene	0.0068	0.0068					0.0085		0.00788
1,2,3-Trichloropropane	0.20			0.25		0.0101			
<b>SEM-VOLATILES</b>									
Phenol	2.61								
Cresol*	1.41							0.48	
2,4-Dimethylphenol	0.83							0.37	
Naphthalene	0.251			0.23				0.43	
2-Methylnaphthalene				0.351				0.45	
2-Chloronaphthalene	4.01	0.341		0.351				0.64	
Benzo(a)pyrene		0.298			0.241			0.321	
Di-n-butylphthalate		0.241		0.231	0.241			0.64	
Fluorene		0.231		0.231	0.241			0.58	
Pyrene		0.231		0.231	0.241			0.4	
Chrysene		0.241		0.121				0.321	
Benzo(b)fluoranthene								0.321	
Benzo(k)fluoranthene								0.211	
Diisocoumarin									
4,4'-DDT	0.028AC			0.028AC		0.042AC			0.028AC
Endosulfan sulfate									
Data prepared by: ERM, Inc. ERM, Inc. ERM, Inc. ERM, Inc. ERM, Inc. ERM, Inc. ERM, Inc. ERM, Inc. ERM, Inc.									

A - Data taken from the 8 December 1986 report  
B - This analysis was also found in the method blank and is of questionable qualitative significance  
J - estimated value  
Blank indicates not detected  
Cresol\* - 2- and 4-methyl phenol  
AC - Not confirmed - the method of analysis can easily generate false positives.  
All ERM data has gone through a quality assurance review.

TABLE 4-17 (continued)  
TYSON'S SITE  
HILLSIDE AREA SOIL RESULTS  
TENTATIVELY IDENTIFIED COMPOUNDS  
mg/kg, dry weight basis

Sample Number Date Sampled Parameter	HS SS 017 A	HS SS 018 A	HS SS 019 A	HS SS 020 A	HS SS 021 A	HS SS 022 A	HS SS 023 A	HS SS 024 A	HS SS 025 A
1,1'-Oxybis-ethane		0.02	0.31	0.02	0.012	0.01			0.01
Pentane		0.03	0.02						1.8
Aliphatic aldehyde		1.27	2.6			1	0.4		2.2
Fatty alcohol			2.37		0.4	0.43	0.4		
3-Pentan-2-one						0.43			
Fatty acid							0.7		
3-Methyl-octane								2.7	
Benzo-bis (1) benzotriphenyls		10.69	0.43	35.3	13	7.77	5.9	0.5	19.3
Diethyl-sepiolene		5.61	4.37	19.36	17.7	45	27.3	9.8	5.3
Total aliphatic hydrocarbons									
Total unknowns									
Date prepared BY:	ERM, Inc.	ERM, Inc.	ERM, Inc.	ERM, Inc.	ERM, Inc.	ERM, Inc.	ERM, Inc.	ERM, Inc.	ERM, Inc.

A-From report dated 8 December 1986.  
Blank indicates not detected.  
All ERM data has gone through a quality assurance review.

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TABLE 4-17 (continued)  
TYPSON'S SITE  
HILLSIDE AREA SOIL RESULTS  
INORGANIC CONSTITUENTS  
mg/kg, dry weight basis

Sample Number	HS SS 017	HS SS 018	HS SS 019	HS SS 020	HS SS 021	HS SS 022	HS SS 023	HS SS 024	HS SS 025
Date sampled									
Parameter									
Aluminum	8010	9800	11200	8150	8500	7270	9000	8460	11600
Antimony	8.7	14.4	10.3	38.4	15.3	8.9	2.86	8.46	23.7
Arsenic	75	56	57	84.7	17.8	17.8	17.8	17.8	56
Beryllium	0.5	0.45	0.34	0.47	0.218	0.43	0.22	0.76	0.39
Cadmium	0.25	0.34	0.34	0.17	0.118	0.118	0.21	0.33	0.22
Chromium	12.5	18.9	12.5	17.6	10.7	11.9	11.6	20.1	16.7
Cobalt	5	5.8	4.5	3.5	2.1	5.4	4.2	7.8	3.3
Copper	18.8	14.6	14.8	31.7	16.1	546	65.6	123	18.8
Iron	7060	11800	8600	17800	9520	10200	8920	20800	12700
Lead	86.6	70.87	60.23	129	52.53	31.5	13.83	104.1	82.23
Manganese	489	167	143	107	34.7	150	181	240	86.1
Mercury	0.13NV	0.112		0.22NV		0.11NV		0.22NV	0.11NV
Nickel	8.8	9	6.8	9.4	5.4	9.8	6.3	15.6	8.8
Selenium	0.758			2.18	0.869			0.893	1.118
Silver				0.25B		0.05NV		0.308	
Titanium									
Vanadium	15.1	18	18.3	31.7	21.4	14.1	13.8	22.3	32.2
Zinc	90.5	52.5	41.2		31.8		24.4	114	70.6
ppb	4.93	4.53	4.45	4.21	4.02	4.86	4.76	3.86	4.01
TOX									
Date prepared by:	ERM, Inc.	ERM, Inc.	ERM, Inc.	ERM, Inc.	ERM, Inc.	ERM, Inc.	ERM, Inc.	ERM, Inc.	ERM, Inc.

A - Data taken from 8 December 1986 report

B - this analyte was also found in the method blank and is of questionable qualitative significance

J - estimated value

Blank indicates not detected

NV - this result is not valid; the laboratory abundance data indicated this concentration is below the detection capability

All ERM data has gone through a quality assurance review.

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TABLE 4-18

OBSERVED RANGE OF SELECTED INORGANIC CONSTITUENTS\*  
FOR SOILS IN THE EASTERN U.S.

<u>Inorganic Constituent</u>	<u>Observed Range</u>	<u>Mean</u>
Aluminum	0.7->1.0%	3.3%
Arsenic	<0.2-73 ppm	5.4 ppm
Barium	15-1000 ppm	300 ppm
Beryllium	<1-7 ppm	0.6 ppm
Cadmium	<1-1 ppm	<1 ppm
Chromium	1-100 ppm	36 ppm
Cobalt	<3-70 ppm	7 ppm
Copper	<1-150 ppm	14 ppm
Iron	0.01->10%	1.5%
Lead	<7-300 ppm	14 ppm
Manganese	<2-7000 ppm	290 ppm
Mercury	10-3400 ppb	96 ppb
Nickel	<3-700 ppm	13 ppm
Selenium	<0.1-1.4 ppm	0.39 ppm
Silver (Western U.S.)	<0.5-5 ppm	<0.5 ppm
Tin	<10-15 ppm	<10 ppm
Thallium	--	--
Vanadium	<5-300 ppm	46 ppm
Zinc	<5-400 ppm	36 ppm

\*Conner, J.J. and Shacklette, H.T. 1975.

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#### 4.4 Seep Area

The seep area is a small area (approximately 150 by 100 feet) located west of the former lagoon area. When the lagoons were active, this area was a gently sloping hillside. During the construction of the nearby residential subdivision soils from the area were reportedly excavated and used as construction fill. Sometime after the soil was removed, the EPA was notified of seepage emanating from the area. A sample of the seepage was collected, and the area backfilled.\* Backfilling eliminated obvious seepage and also created a relatively heterogeneous soil in terms of both physical and chemical properties.

Soils developing in the area were of the Bowmanville series, derived from materials washed from surrounding uplands underlain by shale and sandstone. These soils typically exhibit thin, mottled, reddish brown silty surface horizons, and weak-red, extensively mottled, silty subsoils. Sixteen soil samples were collected from the locations shown on Plate 7.

\*Reportedly, there were no contaminants in this sample.

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### Organic Compounds

Results of the HSL organic analyses are present in Table 4-19. The occurrence of volatile compounds in all samples was qualitatively questionable. Samples SS013 and SS011, collected at depths of 3.3 and 9 feet, respectively, were the only soil samples in which PAHs were detected. Seven compounds ranging in concentration from 0.3 to 1.1 mg/kg with a total PAH concentration of 5.63 mg/kg were detected in Sample SS013. Two compounds with a total PAH concentration of 0.4 mg/kg were detected in Sample SS011. As discussed in Section 4.7, these PAH compounds did not originate from the former lagoon area.

The presence of the pesticide DDT was tentatively identified and the breakdown product DDD was confirmed in sample SS011. Total DDT and DDD concentration was 0.94 mg/kg of which 0.88 mg/kg was DDT. DDT concentration in this sample was the highest level of DDT detected in any of the soil samples.

### Inorganic Constituents

Physically, soils of the seep area exhibited signs of disturbance and fill, e.g., the presence of cinder blocks, wood fragments, black plastic, etc. Chemically, wide variations in the concentration of inorganic constituents were found. However, no depth relationship of the constituents was detected nor was there a relationship between excavations separated by only a few feet. Inorganic constituent concentrations were well within the range reported for soils of the eastern United States (Table 4-18). Highest concentrations of chromium, cobalt, copper, iron, manganese, nickel, vanadium, and zinc were found in a surface

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TABLE 410  
TRENDS SITE  
SEEP AREA ANALYSIS  
WEL ORGANIC COMPOUNDS  
mg/L, dry sample basis

Sample Number	SS 001	SS 002	SS 003	SS 004	SS 005	SS 006	SS 007	SS 008	SS 009	SS 010	SS 011	SS 012	SS 013	SS 014	SS 015	SS 016	SS 017	SS 018	SS 019	SS 020	SS 021	SS 022	SS 023	SS 024	SS 025	SS 026	SS 027	SS 028	SS 029	SS 030	SS 031	SS 032	SS 033	SS 034	SS 035	SS 036	SS 037	SS 038	SS 039	SS 040	SS 041	SS 042	SS 043	SS 044	SS 045	SS 046	SS 047	SS 048	SS 049	SS 050	SS 051	SS 052	SS 053	SS 054	SS 055	SS 056	SS 057	SS 058	SS 059	SS 060	SS 061	SS 062	SS 063	SS 064	SS 065	SS 066	SS 067	SS 068	SS 069	SS 070	SS 071	SS 072	SS 073	SS 074	SS 075	SS 076	SS 077	SS 078	SS 079	SS 080	SS 081	SS 082	SS 083	SS 084	SS 085	SS 086	SS 087	SS 088	SS 089	SS 090	SS 091	SS 092	SS 093	SS 094	SS 095	SS 096	SS 097	SS 098	SS 099	SS 100	SS 101	SS 102	SS 103	SS 104	SS 105	SS 106	SS 107	SS 108	SS 109	SS 110	SS 111	SS 112	SS 113	SS 114	SS 115	SS 116	SS 117	SS 118	SS 119	SS 120	SS 121	SS 122	SS 123	SS 124	SS 125	SS 126	SS 127	SS 128	SS 129	SS 130	SS 131	SS 132	SS 133	SS 134	SS 135	SS 136	SS 137	SS 138	SS 139	SS 140	SS 141	SS 142	SS 143	SS 144	SS 145	SS 146	SS 147	SS 148	SS 149	SS 150	SS 151	SS 152	SS 153	SS 154	SS 155	SS 156	SS 157	SS 158	SS 159	SS 160	SS 161	SS 162	SS 163	SS 164	SS 165	SS 166	SS 167	SS 168	SS 169	SS 170	SS 171	SS 172	SS 173	SS 174	SS 175	SS 176	SS 177	SS 178	SS 179	SS 180	SS 181	SS 182	SS 183	SS 184	SS 185	SS 186	SS 187	SS 188	SS 189	SS 190	SS 191	SS 192	SS 193	SS 194	SS 195	SS 196	SS 197	SS 198	SS 199	SS 200	SS 201	SS 202	SS 203	SS 204	SS 205	SS 206	SS 207	SS 208	SS 209	SS 210	SS 211	SS 212	SS 213	SS 214	SS 215	SS 216	SS 217	SS 218	SS 219	SS 220	SS 221	SS 222	SS 223	SS 224	SS 225	SS 226	SS 227	SS 228	SS 229	SS 230	SS 231	SS 232	SS 233	SS 234	SS 235	SS 236	SS 237	SS 238	SS 239	SS 240	SS 241	SS 242	SS 243	SS 244	SS 245	SS 246	SS 247	SS 248	SS 249	SS 250	SS 251	SS 252	SS 253	SS 254	SS 255	SS 256	SS 257	SS 258	SS 259	SS 260	SS 261	SS 262	SS 263	SS 264	SS 265	SS 266	SS 267	SS 268	SS 269	SS 270	SS 271	SS 272	SS 273	SS 274	SS 275	SS 276	SS 277	SS 278	SS 279	SS 280	SS 281	SS 282	SS 283	SS 284	SS 285	SS 286	SS 287	SS 288	SS 289	SS 290	SS 291	SS 292	SS 293	SS 294	SS 295	SS 296	SS 297	SS 298	SS 299	SS 300	SS 301	SS 302	SS 303	SS 304	SS 305	SS 306	SS 307	SS 308	SS 309	SS 310	SS 311	SS 312	SS 313	SS 314	SS 315	SS 316	SS 317	SS 318	SS 319	SS 320	SS 321	SS 322	SS 323	SS 324	SS 325	SS 326	SS 327	SS 328	SS 329	SS 330	SS 331	SS 332	SS 333	SS 334	SS 335	SS 336	SS 337	SS 338	SS 339	SS 340	SS 341	SS 342	SS 343	SS 344	SS 345	SS 346	SS 347	SS 348	SS 349	SS 350	SS 351	SS 352	SS 353	SS 354	SS 355	SS 356	SS 357	SS 358	SS 359	SS 360	SS 361	SS 362	SS 363	SS 364	SS 365	SS 366	SS 367	SS 368	SS 369	SS 370	SS 371	SS 372	SS 373	SS 374	SS 375	SS 376	SS 377	SS 378	SS 379	SS 380	SS 381	SS 382	SS 383	SS 384	SS 385	SS 386	SS 387	SS 388	SS 389	SS 390	SS 391	SS 392	SS 393	SS 394	SS 395	SS 396	SS 397	SS 398	SS 399	SS 400	SS 401	SS 402	SS 403	SS 404	SS 405	SS 406	SS 407	SS 408	SS 409	SS 410	SS 411	SS 412	SS 413	SS 414	SS 415	SS 416	SS 417	SS 418	SS 419	SS 420	SS 421	SS 422	SS 423	SS 424	SS 425	SS 426	SS 427	SS 428	SS 429	SS 430	SS 431	SS 432	SS 433	SS 434	SS 435	SS 436	SS 437	SS 438	SS 439	SS 440	SS 441	SS 442	SS 443	SS 444	SS 445	SS 446	SS 447	SS 448	SS 449	SS 450	SS 451	SS 452	SS 453	SS 454	SS 455	SS 456	SS 457	SS 458	SS 459	SS 460	SS 461	SS 462	SS 463	SS 464	SS 465	SS 466	SS 467	SS 468	SS 469	SS 470	SS 471	SS 472	SS 473	SS 474	SS 475	SS 476	SS 477	SS 478	SS 479	SS 480	SS 481	SS 482	SS 483	SS 484	SS 485	SS 486	SS 487	SS 488	SS 489	SS 490	SS 491	SS 492	SS 493	SS 494	SS 495	SS 496	SS 497	SS 498	SS 499	SS 500	SS 501	SS 502	SS 503	SS 504	SS 505	SS 506	SS 507	SS 508	SS 509	SS 510	SS 511	SS 512	SS 513	SS 514	SS 515	SS 516	SS 517	SS 518	SS 519	SS 520	SS 521	SS 522	SS 523	SS 524	SS 525	SS 526	SS 527	SS 528	SS 529	SS 530	SS 531	SS 532	SS 533	SS 534	SS 535	SS 536	SS 537	SS 538	SS 539	SS 540	SS 541	SS 542	SS 543	SS 544	SS 545	SS 546	SS 547	SS 548	SS 549	SS 550	SS 551	SS 552	SS 553	SS 554	SS 555	SS 556	SS 557	SS 558	SS 559	SS 560	SS 561	SS 562	SS 563	SS 564	SS 565	SS 566	SS 567	SS 568	SS 569	SS 570	SS 571	SS 572	SS 573	SS 574	SS 575	SS 576	SS 577	SS 578	SS 579	SS 580	SS 581	SS 582	SS 583	SS 584	SS 585	SS 586	SS 587	SS 588	SS 589	SS 590	SS 591	SS 592	SS 593	SS 594	SS 595	SS 596	SS 597	SS 598	SS 599	SS 600	SS 601	SS 602	SS 603	SS 604	SS 605	SS 606	SS 607	SS 608	SS 609	SS 610	SS 611	SS 612	SS 613	SS 614	SS 615	SS 616	SS 617	SS 618	SS 619	SS 620	SS 621	SS 622	SS 623	SS 624	SS 625	SS 626	SS 627	SS 628	SS 629	SS 630	SS 631	SS 632	SS 633	SS 634	SS 635	SS 636	SS 637	SS 638	SS 639	SS 640	SS 641	SS 642	SS 643	SS 644	SS 645	SS 646	SS 647	SS 648	SS 649	SS 650	SS 651	SS 652	SS 653	SS 654	SS 655	SS 656	SS 657	SS 658	SS 659	SS 660	SS 661	SS 662	SS 663	SS 664	SS 665	SS 666	SS 667	SS 668	SS 669	SS 670	SS 671	SS 672	SS 673	SS 674	SS 675	SS 676	SS 677	SS 678	SS 679	SS 680	SS 681	SS 682	SS 683	SS 684	SS 685	SS 686	SS 687	SS 688	SS 689	SS 690	SS 691	SS 692	SS 693	SS 694	SS 695	SS 696	SS 697	SS 698	SS 699	SS 700	SS 701	SS 702	SS 703	SS 704	SS 705	SS 706	SS 707	SS 708	SS 709	SS 710	SS 711	SS 712	SS 713	SS 714	SS 715	SS 716	SS 717	SS 718	SS 719	SS 720	SS 721	SS 722	SS 723	SS 724	SS 725	SS 726	SS 727	SS 728	SS 729	SS 730	SS 731	SS 732	SS 733	SS 734	SS 735	SS 736	SS 737	SS 738	SS 739	SS 740	SS 741	SS 742	SS 743	SS 744	SS 745	SS 746	SS 747	SS 748	SS 749	SS 750	SS 751	SS 752	SS 753	SS 754	SS 755	SS 756	SS 757	SS 758	SS 759	SS 760	SS 761	SS 762	SS 763	SS 764	SS 765	SS 766	SS 767	SS 768	SS 769	SS 770	SS 771	SS 772	SS 773	SS 774	SS 775	SS 776	SS 777	SS 778	SS 779	SS 780	SS 781	SS 782	SS 783	SS 784	SS 785	SS 786	SS 787	SS 788	SS 789	SS 790	SS 791	SS 792	SS 793	SS 794	SS 795	SS 796	SS 797	SS 798	SS 799	SS 800	SS 801	SS 802	SS 803	SS 804	SS 805	SS 806	SS 807	SS 808	SS 809	SS 810	SS 811	SS 812	SS 813	SS 814	SS 815	SS 816	SS 817	SS 818	SS 819	SS 820	SS 821	SS 822	SS 823	SS 824	SS 825	SS 826	SS 827	SS 828	SS 829	SS 830	SS 831	SS 832	SS 833	SS 834	SS 835	SS 836	SS 837	SS 838	SS 839	SS 840	SS 841	SS 842	SS 843	SS 844	SS 845	SS 846	SS 847	SS 848	SS 849	SS 850	SS 851	SS 852	SS 853	SS 854	SS 855	SS 856	SS 857	SS 858	SS 859	SS 860	SS 861	SS 862	SS 863	SS 864	SS 865	SS 866	SS 867	SS 868	SS 869	SS 870	SS 871	SS 872	SS 873	SS 874	SS 875	SS 876	SS 877	SS 878	SS 879	SS 880	SS 881	SS 882	SS 883	SS 884	SS 885	SS 886	SS 887	SS 888	SS 889	SS 890	SS 891	SS 892	SS 893	SS 894	SS 895	SS 896	SS 897	SS 898	SS 899	SS 900	SS 901	SS 902	SS 903	SS 904	SS 905	SS 906	SS 907	SS 908	SS 909	SS 910	SS 911	SS 912	SS 913	SS 914	SS 915	SS 916	SS 917	SS 918	SS 919	SS 920	SS 921	SS 922	SS 923	SS 924	SS 925	SS 926	SS 927	SS 928	SS 929	SS 930	SS 931	SS 932	SS 933	SS 934	SS 935	SS 936	SS 937	SS 938	SS 939	SS 940	SS 941	SS 942	SS 943	SS 944	SS 945	SS 946	SS 947	SS 948	SS 949	SS 950	SS 951	SS 952	SS 953	SS 954	SS 955	SS 956	SS 957	SS 958	SS 959	SS 960	SS 961	SS 962	SS 963	SS 964	SS 965	SS 966	SS 967	SS 968	SS 969	SS 970	SS 971	SS 972	SS 973	SS 974	SS 975	SS 976	SS 977	SS 978	SS 979	SS 980	SS 981	SS 982	SS 983	SS 984	SS 985	SS 986	SS 987	SS 988	SS 989	SS 990	SS 991	SS 992	SS 993	SS 994	SS 995	SS 996	SS 997	SS 998	SS 999	SS 1000	SS 1001	SS 1002	SS 1003	SS 1004	SS 1005	SS 1006	SS 1007	SS 1008	SS 1009	SS 1010	SS 1011	SS 1012	SS 1013	SS 1014	SS 1015	SS 1016	SS 1017	SS 1018	SS 1019	SS 1020	SS 1021	SS 1022	SS 1023	SS 1024	SS 1025	SS 1026	SS 1027	SS 1028	SS 1029	SS 1030	SS 1031	SS 1032	SS 1033	SS 1034	SS 1035	SS 1036	SS 1037	SS 1038	SS 1039	SS 1040	SS 1041	SS 1042	SS 1043	SS 1044	SS 1045	SS 1046	SS 1047	SS 1048	SS 1049	SS 1050	SS 1051	SS 1052	SS 1053	SS 1054	SS 1055	SS 1056	SS 1057	SS 1058	SS 1059	SS 1060	SS 1061	SS 1062	SS 1063	SS 1064	SS 1065	SS 1066	SS 1067	SS 1068	SS 1069	SS 1070	SS 1071	SS 1072	SS 1073	SS 1074	SS 1075	SS 1076	SS 1077	SS 1078	SS 1079	SS 1080	SS 1081	SS 1082	SS 1083	SS 1084	SS 1085	SS 1086	SS 1087	SS 1088	SS 1089	SS 1090	SS 1091	SS 1092	SS 1093	SS 1094	SS 1095	SS 1096	SS 1097	SS 1098	SS 1099	SS 1100	SS 1101	SS 1102	SS 1103	SS 1104	SS 1105	SS 1106	SS 1107	SS 1108	SS 1109	SS 1110	SS 1111	SS 1112	SS 1113	SS 1114	SS 1115	SS 1116	SS 1117	SS 1118	SS 1119	SS 1120	SS 1121	SS 1122	SS 1123	SS 1124	SS 1125	SS 1126	SS 1127	SS 1128	SS 1129	SS 1130	SS 1131	SS 1132	SS 1133	SS 1134	SS 1135	SS 1136	SS 1137	SS 1138	SS 1139	SS 1140	SS 1141	SS 1142	SS 1143	SS 1144	SS 1145	SS 1146	SS 1147	SS 1148	SS 1149	SS 1150	SS 1151	SS 1152	SS 1153	SS 1154	SS 1155	SS 1156	SS 1157	SS 1158	SS 1159	SS 1160	SS 1161	SS 1162	SS 1163	SS 1164	SS 1165	SS 1166	SS 1167	SS 1168	SS 1169	SS 1170	SS 1171	SS 1172	SS 1173	SS 1174	SS 1175	SS 1176	SS 1177	SS 1178	SS 1179	SS 1180	SS 1181	SS 1182	SS 1183	SS 1184	SS 1185	SS 1186	SS 1187	SS 1188	SS 1189	SS 1190	SS 1191	SS 1192	SS 1193	SS 1194	SS 1195	SS 1196	SS 1197	SS 1198	SS 1199	SS 1200
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TABLE 4-16 (Continued)  
TYBONTS SITE  
SEEP AREA SOIL RESULTS  
FOR INORGANIC CONSTITUENTS  
mg/kg dry weight basis

Sample Number	SS 001	SS 002	SS 003	SS 004	SS 005	SS 006	SS 007	SS 008	SS 009	SS 010	SS 011	SS 012	SS 013	SS 014	SS 015	SS 016
Parameter	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Aluminum	8770	12900	9180	7700	9720	9330	11100	6500	10500	9710	8430	18900	16500	11000	13900	12600
Arsenic	4.31	2.603	8.8	3.508	5.43	3.945	4.44	2.618	4.72	3.89	2.98	14.3	9	5.39	7.29	4.83
Barium	74	138	168	88	86	36	86	125	104	117	80	85	84	84	141	34
Bismuth	0.37	0.48	0.58	0.47	0.37	0.24	0.255	0.57	0.35	0.36	0.1847	0.83	0.48	0.228	0.47	0.228
Chromium	8.8	13.8	22.6	8.2	14.8	10.8	14.6	5.7	13.8	10.8	12	15.4	11.1	19	24.7	10.8
Cobalt	4.8	4.8	4.8	3.5	4.8	4.8	4.8	2.3	3.5	3.5	3	34.5	22.8	2.2	8.9	4.5
Copper	8.2	5.7	8.5	4.7	9.8	4.8	8.5	3.4	8.1	8.2	6	34.5	22.8	4.5	11.8	4.5
Iron	7300	12200	21400	5210	9810	7000	10600	4250	9790	7810	8050	38100	10300	15700	21800	12200
Lead	18.5	5.7	9.5	14	23.4	10.8	18.8	4.58	16.4	18.2	23	18.8	38.7	7.8	9.4	7.8
Manganese	131	172	122	108	223	116	146	102	320	317	125	812	321	56.4	186	115
Mercury							0.128				0.0847		0.0847			
Molybdenum	7.4	10.3	7.1	7	6.2	6	7.4	4.5	5.8	4.7	7	27.2	13.2	4.5	8.2	7.8
Selenium											0.08		0.08			
Silver											0.0847		0.08			
Thallium																
Tin	13.5	12.8	13.1	11.7	16	13.1	17.3	6.8	17.3	14.1	12	58.2	28.8	22.5	27.4	20.3
Vanadium	28.7	11.8	21	28.6	38.7	21.1	31.2	7.71	34	48.8	78.8	78.2	77.2	18	33.1	18.1
Zinc	6.42	6.82	6.59	5.98	7.63	7.20	7.81	6.24	7.36	7.48	7.83	7.45	7.33	5.66	8.57	4.86
TKC																

Data reported by ERM, Inc. ERM, Inc. ERM, Inc. ERM, Inc. ERM, Inc. ERM, Inc. ERM, Inc. ERM, Inc. ERM, Inc. ERM, Inc. ERM, Inc. ERM, Inc. ERM, Inc. ERM, Inc. ERM, Inc. ERM, Inc. ERM, Inc.

A - Data taken from 8 December 1986 report  
NYC not valid  
J - estimated value  
B - see result is of questionable qualitative significance since the compound was detected in the blank  
C - did not pass quality control criteria  
D - see result is of questionable qualitative significance since the compound was detected in the blank  
All ERM data has gone through a quality assurance review.

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sample of test pit 6 (Sample SS012, Plate 7). Within this pit, dark reddish brown water was noted to be seeping from the upper depths, suggesting that the high concentrations were attributable to the water seepage. This seepage, however, is not believed to have originated from the Tyson's Site as none of the organic compounds associated with the former lagoons were found in Sample SS012.

#### 4.5 Railroad Area

##### 4.5.1 Borings

Soil borings were installed on both sides of the railroad tracks (Figure 3-5). Distance between borings ranged from 290 to 450 feet, and locations were based upon the ability of the drilling rig to maneuver along the close confines of the tracks and overhead electrical wires.

Soils developing on both sides of the railroad are of the Rowland series. These soils are derived from the weathering of materials washed from uplands underlain by shales and sandstone and alluvial deposits from periodic flooding of the Schuylkill River. These deposits include a layer of coal sediment washed from the anthracite coal regions of Pennsylvania to the far north of the site. Upstream coal piles have reportedly contributed to coal deposition in the river during flood events.

Boring logs are presented in Appendix E. The surface of each of the boring locations was comprised primarily of cinder fill used in the construction of the railroad bed. Approximately 1.4 to

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9.4 feet of cinder fill was reported for the borings. An average fill thickness was 3.6 feet north of the tracks and 3.4 feet south of the tracks. Fill thickness was greatest at the boring located north of the tracks adjacent to the EPA installed air stripper (B-11).

A field description of the fill material revealed that it consisted primarily of bottom ash from the coal combustion process. This was confirmed by a personal communication with Mr. James McKutchin, a Soil Engineer for Conrail. Relative to soils typical of the Eastern United States, the concentrations of the inorganic constituents of cadmium, chromium, mercury, and selenium are greater in bottom ash than in soil material. Subsequently, in areas where bottom ash is used as fill material, soil contamination from these and other constituents may result.

Fill placement in a manner similar of that along the railroad right-of-way may also disrupt natural water movement patterns through the soil vadose (unsaturated) zone. That is, water may flow more readily through the fill as opposed to the soil material, creating somewhat of a channelized course for water flow. This would accelerate the movement of potentially mobile constituents through the railroad area. Conversely, it may provide an area where mobile constituents are absorbed, subsequently reducing their mobility.

#### Organic Compounds

Analytical organic analyses for the ten boreholes is presented in Table 4-20. No organic compounds were quantitatively confirmed in soil samples collected from borings 1, 8, 9, and 10.

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TABLE 4-28  
TYPICAL SITE  
RAILROAD AREA SOIL RESULTS  
HEAVY METAL CONCENTRATIONS  
mg/kg, dry weight basis

Depth (feet) Sample Number Sample Date	SOURCE 1			SOURCE 2			SOURCE 3			SOURCE 4			SOURCE 5			SOURCE 6			SOURCE 7							
	4-6 SS025 A	8-12 SS027 A	12-14 SS028 A	16-18 SS029 A	20-22 SS030 A	24-26 SS031 A	0-2 SS032 A	4-6 SS033 A	8-12 SS034 A	12-14 SS035 A	16-18 SS036 A	20-22 SS037 A	4-6 SS038 A	8-12 SS039 A	12-14 SS040 A	16-18 SS041 A	20-22 SS042 A	4-6 SS043 A	8-12 SS044 A	12-14 SS045 A	16-18 SS046 A	20-22 SS047 A				
Presampler	6550	7080	10200	10500	13500	5800	8640	11300	13600	3770	7410	9130	6820	10700	14100	4050	7300	10500	6030	7600	10500	6030	7600			
Aluminum	514	432	286	104	367	246	4.8	5.9	5.1	4.97	2.85	3.82	2.85	7.08	5.48	12.8	11.5	4.1	4.28	4.1	4.28	4.1	4.28			
Arsenic	78	122	240	177	110	78	117	179	185	53	118	101	40	178	215	8	7.4	38	15	7.4	38	15	7.4			
Beryllium	0.078	1	1.48	0.758	0.818	0.3818	0.358	0.8	0.478	0.328	0.748	0.388	0.488	0.718	2.13	0.33	0.24	0.388	0.24	0.388	0.24	0.388	0.24			
Cadmium	11.2	15.5	20.6	24.9	25.7	11.7	15.2	21.5	22.3	6.3	12.6	18	12.5	18.8	30.2	12.1	11.6	15.5	17.8	15.5	17.8	15.5	17.8			
Chromium	4.5	5.5	8	8.7	4.9	3.9	4.7	4.8	4.7	4.2	5.3	4.5	3.4	8.2	10.1	5.5	8.3	4.8	7.1	4.8	7.1	4.8	7.1			
Cobalt	20.1	15.5	10.3	17.4	14.7	8.1	25.8	20.3	12.9	38.1	28.4	15.7	5.7	10.5	38.9	72.4	77.5	15.5	11.8	15.5	11.8	15.5	11.8			
Copper	9500	9190	13500	28000	21000	6900	12900	20600	19400	8500	8600	12900	8700	22500	21000	1900	21800	19000	18000	21800	19000	18000	21800			
Iron	39.1	17.7	8	13.8	14.8	7.2	15.8	13.8	14.8	14.3	15.8	14.3	15.8	14.3	15.8	14.3	15.8	14.3	15.8	14.3	15.8	14.3	15.8			
Lead	140	159	161	1290	215	153	158	170	133	194	181	155	77.1	288	264	158	442	625	323	221	400	1947	1947			
Manganese	0.2218	0.1118	0.128	0.128	0.128	0.0718	0.0718	0.0518	0.0318	0.0318	0.0318	0.0318	0.0318	0.0318	0.0318	0.0318	0.0318	0.0318	0.0318	0.0318	0.0318	0.0318				
Nickel	11.2	12.2	14.8	14.8	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758				
Selenium																										
Silver																										
Thallium	16.8	18.9	26.6	27.4	31.8	11.7	17.8	28.3	24.7	7.4	17.8	20.2	18.4	25.9	28.1	15.4	58	17.8	18.7	15.4	58	17.8	18.7			
Zinc	30.7	26.6	26.9	40	42.8	25	43.7	38.2	34.1	45.7	44.9	33.1	18.4	42.4	51.8	1.08	94.4	93.8	74.3	94.4	93.8	74.3	94.4			
pH	7.47	7.43	7.53	7.43	7.13	8.86	7.05	8.78	8.23	7.16	7.12	7.16	7.10	8.67	8.89	8.57	8.58	8.15	8.28	8.15	8.28	8.15	8.28			
Statistical							14.6	18.4	14.9							8.8		16.2								
Notes	Data recorded by ERM Inc.																									

A - Data taken from 8 December 1986 report  
B - The sample was also tested in the method blank and is of questionable qualitative significance  
C - This result is not valid; the laboratory absorbance data indicated this concentration is below the detection capability  
D - Blank; indicate not detected  
E - All ERM data has been through a quality assurance review.

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TABLE 4.2C (Continued)  
TYSON'S SITE  
HARBOUR/INLET SEDIMENTARY  
HEAVY METAL CONCENTRATIONS  
mg/kg, dry weight basis

Depth (m)	0-2	4-6	8-12	12-14	15-25	25-45	45-65	65-85	85-100	100-120	120-140	140-160	160-180	180-200	200-220	220-240	240-260	260-280	280-300	300-320	320-340	340-360	360-380	380-400	400-420	420-440	440-460	460-480	480-500	500-520	520-540	540-560	560-580	580-600	600-620	620-640	640-660	660-680	680-700	700-720	720-740	740-760	760-780	780-800	800-820	820-840	840-860	860-880	880-900	900-920	920-940	940-960	960-980	980-1000	1000-1020	1020-1040	1040-1060	1060-1080	1080-1100	1100-1120	1120-1140	1140-1160	1160-1180	1180-1200	1200-1220	1220-1240	1240-1260	1260-1280	1280-1300	1300-1320	1320-1340	1340-1360	1360-1380	1380-1400	1400-1420	1420-1440	1440-1460	1460-1480	1480-1500	1500-1520	1520-1540	1540-1560	1560-1580	1580-1600	1600-1620	1620-1640	1640-1660	1660-1680	1680-1700	1700-1720	1720-1740	1740-1760	1760-1780	1780-1800	1800-1820	1820-1840	1840-1860	1860-1880	1880-1900	1900-1920	1920-1940	1940-1960	1960-1980	1980-2000	2000-2020	2020-2040	2040-2060	2060-2080	2080-2100	2100-2120	2120-2140	2140-2160	2160-2180	2180-2200	2200-2220	2220-2240	2240-2260	2260-2280	2280-2300	2300-2320	2320-2340	2340-2360	2360-2380	2380-2400	2400-2420	2420-2440	2440-2460	2460-2480	2480-2500	2500-2520	2520-2540	2540-2560	2560-2580	2580-2600	2600-2620	2620-2640	2640-2660	2660-2680	2680-2700	2700-2720	2720-2740	2740-2760	2760-2780	2780-2800	2800-2820	2820-2840	2840-2860	2860-2880	2880-2900	2900-2920	2920-2940	2940-2960	2960-2980	2980-3000	3000-3020	3020-3040	3040-3060	3060-3080	3080-3100	3100-3120	3120-3140	3140-3160	3160-3180	3180-3200	3200-3220	3220-3240	3240-3260	3260-3280	3280-3300	3300-3320	3320-3340	3340-3360	3360-3380	3380-3400	3400-3420	3420-3440	3440-3460	3460-3480	3480-3500	3500-3520	3520-3540	3540-3560	3560-3580	3580-3600	3600-3620	3620-3640	3640-3660	3660-3680	3680-3700	3700-3720	3720-3740	3740-3760	3760-3780	3780-3800	3800-3820	3820-3840	3840-3860	3860-3880	3880-3900	3900-3920	3920-3940	3940-3960	3960-3980	3980-4000	4000-4020	4020-4040	4040-4060	4060-4080	4080-4100	4100-4120	4120-4140	4140-4160	4160-4180	4180-4200	4200-4220	4220-4240	4240-4260	4260-4280	4280-4300	4300-4320	4320-4340	4340-4360	4360-4380	4380-4400	4400-4420	4420-4440	4440-4460	4460-4480	4480-4500	4500-4520	4520-4540	4540-4560	4560-4580	4580-4600	4600-4620	4620-4640	4640-4660	4660-4680	4680-4700	4700-4720	4720-4740	4740-4760	4760-4780	4780-4800	4800-4820	4820-4840	4840-4860	4860-4880	4880-4900	4900-4920	4920-4940	4940-4960	4960-4980	4980-5000	5000-5020	5020-5040	5040-5060	5060-5080	5080-5100	5100-5120	5120-5140	5140-5160	5160-5180	5180-5200	5200-5220	5220-5240	5240-5260	5260-5280	5280-5300	5300-5320	5320-5340	5340-5360	5360-5380	5380-5400	5400-5420	5420-5440	5440-5460	5460-5480	5480-5500	5500-5520	5520-5540	5540-5560	5560-5580	5580-5600	5600-5620	5620-5640	5640-5660	5660-5680	5680-5700	5700-5720	5720-5740	5740-5760	5760-5780	5780-5800	5800-5820	5820-5840	5840-5860	5860-5880	5880-5900	5900-5920	5920-5940	5940-5960	5960-5980	5980-6000	6000-6020	6020-6040	6040-6060	6060-6080	6080-6100	6100-6120	6120-6140	6140-6160	6160-6180	6180-6200	6200-6220	6220-6240	6240-6260	6260-6280	6280-6300	6300-6320	6320-6340	6340-6360	6360-6380	6380-6400	6400-6420	6420-6440	6440-6460	6460-6480	6480-6500	6500-6520	6520-6540	6540-6560	6560-6580	6580-6600	6600-6620	6620-6640	6640-6660	6660-6680	6680-6700	6700-6720	6720-6740	6740-6760	6760-6780	6780-6800	6800-6820	6820-6840	6840-6860	6860-6880	6880-6900	6900-6920	6920-6940	6940-6960	6960-6980	6980-7000	7000-7020	7020-7040	7040-7060	7060-7080	7080-7100	7100-7120	7120-7140	7140-7160	7160-7180	7180-7200	7200-7220	7220-7240	7240-7260	7260-7280	7280-7300	7300-7320	7320-7340	7340-7360	7360-7380	7380-7400	7400-7420	7420-7440	7440-7460	7460-7480	7480-7500	7500-7520	7520-7540	7540-7560	7560-7580	7580-7600	7600-7620	7620-7640	7640-7660	7660-7680	7680-7700	7700-7720	7720-7740	7740-7760	7760-7780	7780-7800	7800-7820	7820-7840	7840-7860	7860-7880	7880-7900	7900-7920	7920-7940	7940-7960	7960-7980	7980-8000	8000-8020	8020-8040	8040-8060	8060-8080	8080-8100	8100-8120	8120-8140	8140-8160	8160-8180	8180-8200	8200-8220	8220-8240	8240-8260	8260-8280	8280-8300	8300-8320	8320-8340	8340-8360	8360-8380	8380-8400	8400-8420	8420-8440	8440-8460	8460-8480	8480-8500	8500-8520	8520-8540	8540-8560	8560-8580	8580-8600	8600-8620	8620-8640	8640-8660	8660-8680	8680-8700	8700-8720	8720-8740	8740-8760	8760-8780	8780-8800	8800-8820	8820-8840	8840-8860	8860-8880	8880-8900	8900-8920	8920-8940	8940-8960	8960-8980	8980-9000	9000-9020	9020-9040	9040-9060	9060-9080	9080-9100	9100-9120	9120-9140	9140-9160	9160-9180	9180-9200	9200-9220	9220-9240	9240-9260	9260-9280	9280-9300	9300-9320	9320-9340	9340-9360	9360-9380	9380-9400	9400-9420	9420-9440	9440-9460	9460-9480	9480-9500	9500-9520	9520-9540	9540-9560	9560-9580	9580-9600	9600-9620	9620-9640	9640-9660	9660-9680	9680-9700	9700-9720	9720-9740	9740-9760	9760-9780	9780-9800	9800-9820	9820-9840	9840-9860	9860-9880	9880-9900	9900-9920	9920-9940	9940-9960	9960-9980	9980-10000	10000-10020	10020-10040	10040-10060	10060-10080	10080-10100	10100-10120	10120-10140	10140-10160	10160-10180	10180-10200	10200-10220	10220-10240	10240-10260	10260-10280	10280-10300	10300-10320	10320-10340	10340-10360	10360-10380	10380-10400	10400-10420	10420-10440	10440-10460	10460-10480	10480-10500	10500-10520	10520-10540	10540-10560	10560-10580	10580-10600	10600-10620	10620-10640	10640-10660	10660-10680	10680-10700	10700-10720	10720-10740	10740-10760	10760-10780	10780-10800	10800-10820	10820-10840	10840-10860	10860-10880	10880-10900	10900-10920	10920-10940	10940-10960	10960-10980	10980-11000	11000-11020	11020-11040	11040-11060	11060-11080	11080-11100	11100-11120	11120-11140	11140-11160	11160-11180	11180-11200	11200-11220	11220-11240	11240-11260	11260-11280	11280-11300	11300-11320	11320-11340	11340-11360	11360-11380	11380-11400	11400-11420	11420-11440	11440-11460	11460-11480	11480-11500	11500-11520	11520-11540	11540-11560	11560-11580	11580-11600	11600-11620	11620-11640	11640-11660	11660-11680	11680-11700	11700-11720	11720-11740	11740-11760	11760-11780	11780-11800	11800-11820	11820-11840	11840-11860	11860-11880	11880-11900	11900-11920	11920-11940	11940-11960	11960-11980	11980-12000	12000-12020	12020-12040	12040-12060	12060-12080	12080-12100	12100-12120	12120-12140	12140-12160	12160-12180	12180-12200	12200-12220	12220-12240	12240-12260	12260-12280	12280-12300	12300-12320	12320-12340	12340-12360	12360-12380	12380-12400	12400-12420	12420-12440	12440-12460	12460-12480	12480-12500	12500-12520	12520-12540	12540-12560	12560-12580	12580-12600	12600-12620	12620-12640	12640-12660	12660-12680	12680-12700	12700-12720	12720-12740	12740-12760	12760-12780	12780-12800	12800-12820	12820-12840	12840-12860	12860-12880	12880-12900	12900-12920	12920-12940	12940-12960	12960-12980	12980-13000	13000-13020	13020-13040	13040-13060	13060-13080	13080-13100	13100-13120	13120-13140	13140-13160	13160-13180	13180-13200	13200-13220	13220-13240	13240-13260	13260-13280	13280-13300	13300-13320	13320-13340	13340-13360	13360-13380	13380-13400	13400-13420	13420-13440	13440-13460	13460-13480	13480-13500	13500-13520	13520-13540	13540-13560	13560-13580	13580-13600	13600-13620	13620-13640	13640-13660	13660-13680	13680-13700	13700-13720	13720-13740	13740-13760	13760-13780	13780-13800	13800-13820	13820-13840	13840-13860	13860-13880	13880-13900	13900-13920	13920-13940	13940-13960	13960-13980	13980-14000	14000-14020	14020-14040	14040-14060	14060-14080	14080-14100	14100-14120	14120-14140	14140-14160	14160-14180	14180-14200	14200-14220	14220-14240	14240-14260	14260-14280	14280-14300	14300-14320	14320-14340	14340-14360	14360-14380	14380-14400	14400-14420	14420-14440	14440-14460	14460-14480	14480-14500	14500-14520	14520-14540	14540-14560	14560-14580	14580-14600	14600-14620	14620-14640	14640-14660	14660-14680	14680-14700	14700-14720	14720-14740	14740-14760	14760-14780	14780-14800	14800-14820	14820-14840	14840-14860	14860-14880	14880-14900	14900-14920	14920-14940	14940-14960	14960-14980	14980-15000	15000-15020	15020-15040	15040-15060	15060-15080	15080-15100	15100-15120	15120-15140	15140-15160	15160-15180	15180-15200	15200-15220	15220-15240	15240-15260	15260-15280	15280-15300	15300-15320	15320-15340	15340-15360	15360-15380	15380-15400	15400-15420	15420-15440	15440-15460	15460-15480	15480-15500	15500-15520	15520-15540	15540-15560	15560-15580	15580-15600	15600-15620	15620-15640	15640-15660	15660-15680	15680-15700	15700-15720	15720-15740	15740-15760	15760-15780	15780-15800	15800-15820	15820-15840	15840-15860	15860-15880	15880-15900	15900-15920	15920-15940	15940-15960	15960-15980	15980-16000	16000-16020	16020-16040	16040-16060	16060-16080	16080-16100	16100-16120	16120-16140	16140-16160	16160-16180	16180-16200	16200-16220	16220-16240	16240-16260	16260-16280	16280-16300	16300-16320	16320-16340	16340-16360	16360-16380	16380-16400	16400-16420	16420-16440	16440-16460	16460-16480	16480-16500	16500-16520	16520-1654
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Estimated concentrations of pyrene (.22 mg/kg) were detected in boring 1, and 1,2,3-trichloropropane (.151 mg/kg), tetrachloroethene (.0073 mg/kg), and total xylene (.0055 mg/kg) were detected in boring 9. The following paragraphs discuss borings 2 through 7 individually:

## B2

Two halogenated benzene compounds and five PAHs were quantitatively confirmed in the surface sample at this location. Total PAH concentration observed was 2.57 mg/kg. The observed value for 1,2-dichlorobenzene (0.44 mg/kg) and 1.1 mg/kg for 1,2,4-trichlorobenzene yields a total substituted benzene value of 1.54 mg/kg. 1,2-dichlorobenzene and 1,2,4-trichlorobenzene were quantitatively confirmed in only one additional boring, B-4.

Five volatile compounds were detected, including ethylbenzene (0.008 mg/kg) at the surface and tetrachloroethylene at the surface (0.02 mg/kg) and mid-depth (0.01 mg/kg). A single observation of trichloroethylene (0.011 mg/kg) was made at the surface. 1,2,3-trichloropropane and xylenes were found at all depths sampled. Both were observed to decrease with depth ranging from 0.15 to 0.012 mg/kg and 0.04 to 0.008 mg/kg, respectively.

## B3

No semi-volatiles or volatile compounds were quantitatively confirmed at the surface in this boring. Two PAH compounds were detected at the 4 to 6 foot depth with a total PAH concentrations of 0.84 mg/kg. Ethylbenzene was detected at the 8 to 12 (0.0079

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mg/kg) and 20 to 22 (0.025) foot depths but not at the 12 to 14 foot depth. Xylenes were observed in the three lowest sampling depths in concentrations less than 0.13 mg/kg. Chlorobenzene (0.0071 mg/kg) was observed at the 20 to 22 foot interval. Two PAHs were detected in the 4 to 6 foot depth sample; the total PAH concentration was 0.84 mg/kg.

#### B4

No volatile organic compounds were quantitatively confirmed in samples collected in boring 4, however estimated concentrations were determined for seven compounds. Five semi-volatile compounds were quantitatively confirmed in the sample collected from this boring. Three substituted benzenes were detected including 1,2- and 1,4-dichlorobenzene at 1.57 and 0.62 mg/kg, respectively, and 1,2,4-trichlorobenzene at 3.8 mg/kg for a total substituted benzene concentration of 6 mg/kg. Two PAHs, phenanthrene (0.45 mg/kg) and 2-methylnaphthalene (0.45 mg/kg) were also detected.

#### B5

Soils samples at five depths ranging from the surface to 22 feet were collected at Boring B5. Three PAHs (phenanthrene, naphthalene, 2-methylnaphthalene) were detected in the surface sample with a total concentration of 1.28 mg/kg.

Four of 19 volatile compounds detected in the 0 to 2 and 4 to 6 foot sampling intervals were quantitatively confirmed. These compounds include xylene at 0.13 mg/kg and three PAHs with a total concentration of 1.28 mg/kg. Only 1,2,3-trichloropropane,

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tetrachloroethene, and xylene were quantitatively confirmed at depths exceeding 6 feet. 1,2,3-trichloropropane and xylene were also detected in the 20 to 22 foot sampling interval, however, the concentration for 1,2,3-trichloropropane was estimated.

B6

This boring consisted of only a surface sample which contained three PAH's with a total concentration of 2.16 mg/kg. In addition, five semi-volatile compounds were qualitatively confirmed and four volatiles, including tetrachloroethylene (0.14 mg/kg), trichloroethylene (0.051 mg/kg), 1,2,3-trichloropropane (0.083 mg/kg), and xylenes (0.011 mg/kg), were detected.

B7

This boring was sampled at four depths with only one semi-volatile compound quantitatively confirmed. Fluoranthene was detected (0.44 mg/kg) in the 4 to 6 foot sample. Eight additional semi-volatile compounds were qualitatively identified.

In summary, a total of ten borings were sampled at thirty-three sampling depths. Based on the total number of observations, the most frequently detected semi-volatiles were phenanthrene, pyrene, and fluoranthene. The three most frequently detected volatiles were xylenes, 1,2,3-trichloropropane, and tetrachloroethylene.

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A total of 15 tentatively (i.e., qualitatively) identified compounds were detected. All compounds detected in blanks have been removed from the table.

#### Inorganic Constituents

The concentrations of inorganic constituents in the subsurface soil samples is presented in Table 4-20. All concentrations are well within or below the typical ranges reported for soils in the Eastern United States (Table 4-18). Soil pH values were generally neutral (i.e., 6.6 to 7.3) except for the samples collected from boring 5. Values for soil samples collected between 4 and 14 feet ranged from moderately alkaline to strongly alkaline (7.9 to >9.1). An explanation for these elevated pH values is not apparent.

#### 4.5.2 Soil Gas

The combination of insensitivity of the Foxboro OVA 128 GC to the concentration levels present in the soil gas vapors and its ability to effectively separate the individual compounds led to little definitive qualitative and quantitative information. The value of the soil gas sampling was evaluated in the field after completion of the first three borings (S-1, S-2, and S-3), and it was decided that continuation at additional locations would not be beneficial. Soil samples were collected from the remaining locations (S-4 through S-8) so that possible headspace analyses using the portable GC could be performed under controlled conditions.

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The soil gas analyses of S-1, S-2, and S-3 provided some useful qualitative information. The chromatograms for the three locations indicated multiple peaks, many off-scale, for the early retention times (less than one minute). S-1 revealed three major components from the one minute retention time (RT) to backflushing at approximately 6.9 minutes. Backflushing of the column (6.9 to 13.8 min.) revealed multiple peaks indicative of higher molecular weight compounds. S-2 and S-3 samples revealed similar chromatographs with two compounds eluting at RT 0.5 min. and RT 0.9 min, respectively. Backflushing of the column produced multiple peaks for S-3 while S-2 did not indicate that additional higher molecular weight compounds were present.

To allow better separation of early eluting compounds, a 24-inch column (packing is as in Section 3.4.2) was added to the portable GC and sample S-3 was chromatogrammed again. This chromatograph pattern was similar in appearance to the 12-inch columns, but better definition of the peaks was achieved. Multiple off-scale peaks occurred below RT of 0.44 min. Eight major components can be identified from RT 0.8 to 2.5 min.

Positive retention time matching of the sample chromatograms to the TCP standard chromatogram was difficult due to the low response of the OVA 128 GC to the concentration levels present in the samples and slight variations in column temperature which in turn affected retention times. Therefore, quantification could not be performed. OVA readings recorded using the PID indicate the total concentrations of the sample components to be 26.1 ppm for S-1, 45.2 ppm for S-2, and 59.0 ppm for S-3.

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Although individual compounds were not identified and quantified, the soil gas analyses did reveal that elevated concentrations of multiple components existed at the three locations.

#### 4.6 Floodplain/Wetlands Area

##### 4.6.1 Field Reconnaissance

Vegetation observed by transect are presented in Table 4-21 as well as observations made off the transects. In addition to species observed, the U.S. Fish and Wildlife Service classification as to wetland indicator status is also presented. As expected, based on topographic differences, the Floodplain/Wetlands Operable Unit supports a diverse flora consisting of both upland and wetland-related vegetation. The floodplain proper supports primarily wetland related flora (Transects 1-7). The elevated portion of the unit adjacent to the railroad access road supports a mix of vegetation consisting of upland and wetland plants. No areas of stressed vegetation were observed either during field investigations or follow-up walk-overs. Examination of infrared photographs of the site and surrounding area support the field observations of no areas of stressed vegetation.

In addition to the vegetation survey of the downgradient area, aerial photographs of the former lagoon area and downgradient

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TABLE 4-21  
 SPECIES OF VEGETATION OBSERVED  
 (1 of 5)

Transect 1

<u>Scientific Name</u>	<u>Common Name</u>	<u>Indicator Status</u> <sup>1</sup>
<u>Acer negundo</u>	Boxelder	FACW
<u>A. saccharinum</u>	Silver Maple	FACW
<u>Brassica rapa</u>	Field Mustard	----
<u>Fraxinus pennsylvanica</u>	Green Ash	FACW
<u>Impatiens capensis</u>	Spotted Jewelweed	FACW
<u>Onoclea sensibilis</u>	Sensitive Fern	FACW
<u>Rhus radicans</u>	Poison Ivy	FACW?
<u>Salix nigra</u>	Black Willow	OBL
<u>Vitis sp.</u>	Grape	----

Transect 2

<u>Acer saccharinum</u>	Silver Maple	FACW
<u>Brassica rapa</u>	Field Mustard	----
<u>Circaea aplina</u>	Dwarf Enchanter's Nightshade	FACW
<u>Lindera benzoin</u>	Spicebush	FACW
<u>Liriodendron tulipifera</u>	Tuplptree	----
<u>Lysimachia ciliata</u>	Fringed Loosestrife	FACW
<u>Morus rubra</u>	Red Mulberry	----
<u>Parthenocissus quinquefolia</u>	Virginia Creeper	----
<u>Phytolacca americana</u>	Pokeberry	----
<u>Podophyllum peltatum</u>	Mayapple	----
<u>Rubus sp.</u>	Blackberry	----
<u>Rumex obtusifolius</u>	Bitter Dock	FACW?
<u>Sambucus canadensis</u>	Common Elderberry	FACW
<u>Ulmus americana</u>	American Elm	FACW
<u>Vitis sp.</u>	Grape	----

Transect 3

<u>Acer negundo</u>	Boxelder	FACW
<u>A. rubrum</u>	Red Maple	FAC
<u>A. saccharinum</u>	Silver Maple	FACW
<u>Aralia nudicaulis</u>	Wild Sarsaparilla	FACU
<u>Arisaema triphyllum</u>	Jack-in-the-Pulpit	FACW

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TABLE 4-21 (cont'd)  
SPECIES OF VEGETATION OBSERVED  
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<u>Scientific Name</u>	<u>Common Name</u>	<u>Indicator Status</u> <u>1</u>
<u>Cuscuta gronovii</u>	Common Dodder	----
<u>Fraxinus pennsylvanicus</u>	Green Ash	FACW
<u>Impatiens capensis</u>	Spotted Jewelweed	FACW
<u>Lindera benzoin</u>	Spicebush	FACW
<u>Liriodendron tulipifera</u>	Tupliltree	----
<u>Lobelia cardinalis</u>	Cardinal Flower	OBL?
<u>Lonicera japonica</u>	Japanese Honeysuckle	----
<u>Platanus occidentalis</u>	Sycamore	FACW
<u>Parthenocissus quinquefolia</u>	Virginia Creeper	----
<u>Podophyllum peltatum</u>	Mayapple	----
<u>Quercus palustris</u>	Pin Oak	FACW
<u>Rhus radicans</u>	Poison Ivy	FACW?
<u>Rubus sp.</u>	Blackberry	----
<u>Vitis sp.</u>	Grape	----

Transect 4

<u>Arisaema triphyllum</u>	Jack-in-the-Pulpit	FACW
<u>Brassica rapa</u>	Field Mustard	----
<u>Fraxinus pennsylvanicus</u>	Green Ash	FACW
<u>Impatiens capensis</u>	Spotted Jewelweed	FACW
<u>Lindera benzoin</u>	Spicebush	FACW
<u>Liriodendron tulipifera</u>	Tupliltree	----
<u>Lonicera japonica</u>	Japanese Honeysuckle	----
<u>Lythrum salicaria</u>	Purple Loosestrife	OBL?
<u>Oxalis europaea</u>	Yellow Wood Sorrel	----
<u>Parthenocissus quinquefolia</u>	Virginia Creeper	----
<u>Platanus occidentalis</u>	Sycamore	FACW
<u>Podophyllum peltatum</u>	Mayapple	----
<u>Potentilla simplex</u>	Common Cinquefoil	----
<u>Prunus avium</u>	Sweet Cherry	----
<u>Quercus rubra</u>	Red Oak	FACU
<u>Rhus radicans</u>	Poison Ivy	FACW?
<u>Rubus sp.</u>	Blackberry	----
<u>Ulmus americana</u>	American Elm	FACW
<u>Vitis sp.</u>	Grape	----

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TABLE 4-21 (cont'd)  
SPECIES OF VEGETATION OBSERVED  
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<u>Scientific Name</u>	<u>Common Name</u>	<u>Indicator Status</u> <u>1</u>
<u>Transect 5</u>		
<u>Acer rubrum</u>	Red Maple	FAC
<u>Arisaema triphyllum</u>	Jack-in-the-Pulpit	FACW
<u>Brassica rapa</u>	Field Mustard	----
<u>Castanea dentata</u>	American Chestnut	----
<u>Carya cordiformis</u>	Bitternut Hickory	FAC
<u>Cornus racemosa</u>	Panicked Dogwood	FACW
<u>Fraxinus pennsylvanica</u>	Green Ash	FACW
<u>Impatiens capensis</u>	Spotted Jewelweed	FACW
<u>Juncus sp.</u>	Rush	FACW or OBL
<u>Lindera benzoin</u>	Spicebush	FACW
<u>Liriodendron tulipifera</u>	Tuplptree	----
<u>Lonicera japonica</u>	Japanese Honeysuckle	----
<u>Lythrum salicaria</u>	Purple Loosestrife	OBL?
<u>Onoclea sensibilis</u>	Sensitive Fern	FACW
<u>Parthenocissus quinquefolia</u>	Virginia Creeper	----
<u>Podophyllum peltatum</u>	Mayapple	----
<u>Polygonum sp.</u>	Smartweed	FACW or OBL
<u>Quercus rubra</u>	Red Oak	FACU
<u>Rhus radicans</u>	Poison Ivy	FACW?
<u>Rubus sp.</u>	Blackberry	----
<u>Rumex obtusifolius</u>	Bitter Dock	FACW?
<u>Smilacina racemosa</u>	False Solomon's Seal	----
<u>Ulmus americana</u>	American Elm	FACW
<u>Viburnum acerifolium</u>	Maple-leaved Viburnum	----
<u>Viola sp.</u>	Violet	----
<u>Transect 6</u>		
<u>Acer negundo</u>	Boxelder	FACW
<u>A. rubrum</u>	Red Maple	FAC
<u>A. saccharinum</u>	Silver Maple	FACW
<u>Achillea millefolium</u>	Yarrow	FACU
<u>Allium canadense</u>	Wild Onion	FACU
<u>Arisaema triphyllum</u>	Jack-in-the-Pulpit	FACW
<u>Betula nigra</u>	River Birch	OBL
<u>Cornus racemosa</u>	Panicked Dogwood	FACW

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TABLE 4-21 (cont'd)  
 SPECIES OF VEGETATION OBSERVED  
 (4 of 5)

<u>Scientific Name</u>	<u>Common Name</u>	<u>Indicator Status</u> <u>1</u>
<u>Impatiens capensis</u>	Spotted Jewelweed	FACW
<u>Juglans nigra</u>	Black Walnut	FACU
<u>Lindera benzoin</u>	Spicebush	FACW
<u>Liriodendron tulipifera</u>	Tuplertree	----
<u>Lonicera japonica</u>	Japanese Honeysuckle	----
<u>Lythrum salicaria</u>	Purple Loosestrife	OBL?
<u>Oenothera sensibilis</u>	Sensitive Fern	FACW
<u>Parthenocissus quinquefolia</u>	Virginia Creeper	----
<u>Phragmites communis</u>	Common Reed	FACW
<u>Podophyllum peltatum</u>	Mayapple	----
<u>Populus grandidentata</u>	Bigtoothed Aspen	FACU
<u>Prunus serotina</u>	Black Cherry	FACU
<u>Quercus palustris</u>	Pin Oak	FACW
<u>Q. rubra</u>	Red Oak	FACU
<u>Rhus radicans</u>	Poison Ivy	FACW?
<u>Rosa sp.</u>	Rose	----
<u>Rubus sp.</u>	Blackberry	----
<u>Rumex obtusifolius</u>	Bitter Dock	FACW?
<u>Sassafras albidum</u>	Sassafras	FACU
<u>Ulmus americana</u>	American Elm	FACW
<u>Viburnum prunifolium</u>	Blackhaw	FACU
<u>Vitis sp.</u>	Grape	----

Transect 7

<u>Acer rubrum</u>	Red Maple	FAC
<u>A. saccharinum</u>	Silver Maple	FACW
<u>Betula nigra</u>	River Birch	OBL
<u>Brassica rapa</u>	Field Mustard	----
<u>Celtis occidentalis</u>	Hackberry	----
<u>Cornus racemosa</u>	Panicled Dogwood	FACW
<u>Erigeron annuus</u>	Daisy Fleabane	FAC
<u>Fraxinus pennsylvanica</u>	Green Ash	FACW
<u>Impatiens capensis</u>	Spotted Jewelweed	FACW
<u>Juglans nigra</u>	Black Walnut	FACU
<u>Lindera benzoin</u>	Spicebush	FACW
<u>Lonicera japonica</u>	Japanese Honeysuckle	----
<u>Parthenocissus quinquefolia</u>	Virginia Creeper	----

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TABLE 4-21 (cont'd)  
SPECIES OF VEGETATION OBSERVED  
(5 of 5)

<u>Scientific Name</u>	<u>Common Name</u>	<u>Indicator Status</u> <sup>1</sup>
<u>Phytolacca americana</u>	Pokeberry	----
<u>Prunus serotina</u>	Black Cherry	FACU
<u>Rhus radicans</u>	Poison Ivy	FACW?
<u>Rosa multiflora</u>	Multiflora Rose	----
<u>Rubus sp.</u>	Blackberry	----
<u>Rumex obtusifolius</u>	Bitter Dock	FACW?
<u>Tilia americana</u>	Basswood	FACU
<u>Ulmus americana</u>	American Elm	FACW

Other Plant Species Observed Off Transects

<u>Allanthus altissima</u>	Tree of Heaven	----
<u>Alliaria officinalis</u>	Garlic Mustard	----
<u>Apocynum cannabinum</u>	Indian Hemp	FAC?
<u>Chrysanthemum leucanthemum</u>	Oxeye Daisy	----
<u>Eupatorium maculatum</u>	Spotted Joe-Pye-Weed	OBL
<u>Gum canadense</u>	White Avens	----
<u>Gleditsia triacanthos</u>	Honeylocust	FAC
<u>Hamamelis virginiana</u>	Witchhazel	----
<u>Hemerocallis fulva</u>	Daylily	----
<u>Justicia americana</u>	Water-willow	OBL
<u>Leonurus cardiaca</u>	Motherwort	----
<u>Melilotus officinalis</u>	Yellow Sweet Clover	FACU
<u>Nasturtium officinale</u>	Watercress	OBL
<u>Saururus cernuus</u>	Lizard's Tail	OBL
<u>Solanum dulcamara</u>	Bittersweet Nightshade	FAC?
<u>Staphylea trifolia</u>	American Bladdernut	----
<u>Thalictrum dioicum</u>	Tall Meadow Rue	----
<u>Urtica dioica</u>	Stinging Nettle	----
<u>Verbascum thapsis</u>	Common Mullein	----

<sup>1</sup>Indicator statuses from Wetland Plant List, National Wetlands Inventory Central Control group, St. Petersburg, FL, revised 27 August 1982. Computer printout, 42 pp.

Key to Indicator Statuses:

OBL = obligate hydrophyte      99% of the time found in wetlands  
FACW = facultative-wet      66-99% " " " " " "  
FAC = facultative      33-66% " " " " " "  
FACU = facultative upland      33% " " " " " "

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areas were reviewed for identification of vegetation affected by waste disposal at the site. These photographs included:

- Two normal color, oblique-angle, aerial photographs, September 1984 (Scale approximately 1:10,000)
- Two color infrared, vertical-angle, aerial photographs, September 1970 and April 1981, respectively (Scale approximately 1:65,000)
- One color infrared, vertical-angle aerial photograph, February 1974 (Scale approximately 1:120,000)

The former lagoon area was not visible on the normal color, oblique-angle photographs due to the angle at which these photographs were taken. Vegetation downgradient of the site was visible and all vegetation appeared normal. This is not uncommon as vegetative stress, unless severe, will not appear in normal color photographs. Paine (1981) reported that stressed vegetation can be detected on color infrared photographs before it becomes visible to any other film or to the human eye, provided photographs are taken from low altitudes (large scale), and during periods of active growth. On the IR photographs examined, vegetation appeared normal, however the identification of stressed vegetation was limited by the relatively small scale of the photos. Additionally, on the 1981 photograph, the hardwood species which dominate the site and the downgradient area were in the winter dormant stage and were defoliated, making stress identification impractical.

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Avifauna observed in the Floodplain/Wetlands Operable Unit are presented in Table 4-22. A total of twenty-six species of birds were observed during the June reconnaissance. Juvenile (Young of the Year) ring-necked pheasants were consistently observed during additional field work with a maximum of eleven juvenile pheasants observed during a single trip on the railroad access road.

Mammals observed during the reconnaissance survey and subsequent site trips include opossum, cottontail, squirrel, raccoon, and deer. Amphibians observed include the pickerel and green frogs observed in the pond/swamp area and in the air stripper discharge ditch. Snapping turtles were reportedly observed in the pond/swamp area by ERM geologists during the spring field investigations. By the time of the floodplain reconnaissance, the pond area had been reduced to an area of approximately one-eighth acre with a maximum water depth of 4-6 inches. ERM geologists observed a juvenile snapping turtle in the vicinity of Well Nest 8 in mid-September.

The site appears to support a diverse and unimpacted flora and associated fauna. No areas of stressed vegetation were observed during the site investigations or from photo interpretation of the 1974 and 1981 infrared aerial photographs. Observation of fauna indicated random distribution with no specific area(s) of avoidance.

#### 4.6.2 Wetland Classification

Approximate wetland locations in the floodplain area north of the former lagoons are identified and classified on Plate 6; a field verification of the USFWS Wetland Map for the Norristown

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TABLE 4-22  
SPECIES OF WILDLIFE OBSERVED  
(1 of 1)

BIRDS

<u>Scientific Name</u>	<u>Common Name</u>
<u>Butorides striatus</u>	Green-backed Heron
<u>Phasianus colchicus</u>	Ring-necked Pheasant
<u>Zenaidura macroura</u>	Mourning Dove
<u>Picoides pubescens</u>	Downy Woodpecker
<u>Colaptes auratus</u>	Northern Flicker
<u>Contopus virens</u>	Eastern Wood-Pewee
<u>Myiarchus cinerascens</u>	Great Crested Flycatcher
<u>Tyrannus tyrannus</u>	Eastern Kingbird
<u>Corvus brachyrhynchos</u>	American Crow
<u>Parus atricapillus</u>	Black-capped Chickadee
<u>P. bicolor</u>	Tufted Titmouse
<u>Thryothorus ludovicianus</u>	Carolina Wren
<u>Troglodytes aedon</u>	House Wren
<u>Hylocichla ustulata</u>	Wood Thrush
<u>Turdus migratorius</u>	American Robin
<u>Bombycilla cedrorum</u>	Cedar Waxwing
<u>Sturnus vulgaris</u>	European Starling
<u>Vireo griseus</u>	White-eyed Vireo
<u>V. olivaceus</u>	Red-eyed Vireo
<u>Geothlypis trichas</u>	Common Yellowthroat
<u>Cardinalis cardinalis</u>	Northern Cardinal
<u>Passerina cyanea</u>	Indigo Bunting
<u>Pipilo erythrophthalmus</u>	Rufous-sided Towhee
<u>Melospiza melodia</u>	Song Sparrow
<u>Agelaius phoeniceus</u>	Red-winged Blackbird
<u>Carduelis tristis</u>	American Goldfinch

MAMMALS

<u>Didelphis virginianus</u>	Virginia Opossum
<u>Sylvilagus floridanus</u>	Eastern Cottontail
<u>Sciurus carolinensis</u>	Gray Squirrel
<u>Procyon lotor</u>	Raccoon
<u>Odocoileus virginianus</u>	White-tailed Deer

REPTILES

<u>Rana palustris</u>	Picker Frog
<u>R. clamitans</u>	Green Frog
<u>Chelydra serpentina</u>	Snapping Turtle

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Quadrangle. The soils in the floodplain are classified by the Soil Conservation Survey as Rowland Silt Loam, coal overwash with a Bowmansville hydric component. During field surveys, soil chroma at approximately 6-10 inch depths were compared to Munsell soil color charts for chroma of 2 or less. Plant observations during the reconnaissance survey are presented in Section 4.6.1.1 and Table 4-21. These were supplemented by additional random transects in the wetland areas conducted in July 1987.

The largest portion of the wetlands are classified as Palustrine Forest - Scrub Shrub, broadleaved deciduous, seasonally flooded  
P FO 1C.

SS

The forested component consisted of red maple, green ash, black willow, river birch, and panicled dogwood. The scrub-shrub component included young red maple, green ash, bitternut hickory, spicebush, poison ivy, and boxelder. A number of other wetland related understory plants were located in this area, including spotted jewelweed, jack-in-the-pulpit, and purple loosestrife.

Two small areas were classified as Palustrine-Emergent-narrow leaved persistent-seasonal saturated. PEM5E. One area near the railroad signal tower supported a dense cover of spotted jewelweed. The second area supported a dense growth of purple loosestrife with a spotted jewelweed fringe toward the river.

The easternmost wetland area; frequently referred to as the pond, was classified as Palustrine-Unconsolidatd Bottom-organic-seasonal saturated-PUB4E. This area was observed to go dry toward the end of the summer of 1986. The soft organic sediment

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did not support any wetland vegetation. During the latter part of the summer of 1986, after having been dry for several weeks, a part of this area supported a sparse cover of young upland grass, probably crab grass.

Wetland related vegetation was observed throughout the floodplain, especially in the vicinity of the drainage ditches and in other scattered areas. The contiguous wetlands are presented in Plate 6. No effort was made to classify or map the various disjunct areas supporting wetland related vegetation.

#### 4.6.3 Environmental Sampling

As discussed in Section 3.5.2, surface water and sediment samples were taken in March 1987 at each of the three surface water discharges to the Schuylkill River and the spring to the west of the former lagoon areas. These samples were taken during a period of significant precipitation and high flow and are shown as samples FP-001 thru FP-004 on Table 4-23 (Sediments) and Table 4-24 (Water). Five additional sediment samples were collected at this time at random floodplain locations for TOC and grain size analysis (Table 4-23 and Table 4-25, respectively). All of the sampling locations are shown on Plate 7.

The highest metal concentrations in a sediment sample were detected in sample FP-003 taken from the ponded area receiving the air stripper discharge. 1,2,3-trichloropropane was detected in the sediment samples taken at the spring, the ponded area receiving the air stripper discharge, and the mast in ditch (0.04, 0.037, and 0.037 mg/kg, respectively). Other site related compounds were detected in each of the areas at concentrations

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TABLE 4-23  
TYSON'S SITE  
FLOODPLAIN AREA SEDIMENT SAMPLES (SURFACE WATER DISCHARGE AREAS)  
HSL INORGANIC CONSTITUENTS  
March, 1987  
(concentrations in mg/kg, dry wt. basis)

CONSTITUENT	FP-001 spring	FP-002 western ditch	FP-003 ponded area at stripper discharge	FP-004 eastern ditch	FP-005	FP-006	FP-007	FP-008	FP-009
ALUMINUM	4410.	11000.	17000.	8030.	N/A	N/A	N/A	N/A	N/A
ARSENIC	4.93	5.98	9.08	4.72	N/A	N/A	N/A	N/A	N/A
BARIUM	82.7	83.8	188	91.3	N/A	N/A	N/A	N/A	N/A
BERYLLIUM	0.29	0.54	0.96	0.63	N/A	N/A	N/A	N/A	N/A
CADMIUM		0.41 B	2.23	0.79	N/A	N/A	N/A	N/A	N/A
CHROMIUM	8.7	19.0	57.3	20.5	N/A	N/A	N/A	N/A	N/A
COBALT	4.4	12.2	31.8	11.0	N/A	N/A	N/A	N/A	N/A
COFFER	23.2	28.5	78.0	40.9	N/A	N/A	N/A	N/A	N/A
IRON	11800.	16300	26900	13300	N/A	N/A	N/A	N/A	N/A
LEAD	47.9	72.0	104	55.1	N/A	N/A	N/A	N/A	N/A
MANGANESE	437.	457	1470	486.	N/A	N/A	N/A	N/A	N/A
NICKEL	7.3	16.3	49.4	17.3	N/A	N/A	N/A	N/A	N/A
SELENIUM		1.36	2.07	0.94	N/A	N/A	N/A	N/A	N/A
SILVER	4.4	25.8	0.48	14.2	N/A	N/A	N/A	N/A	N/A
VANADIUM	61.1	115	291	156.	N/A	N/A	N/A	N/A	N/A
ZINC	12,000	23,000	24,000	13,000	6,500	9,600	17,000	6,500	15,000
TDC									

Qualifier Codes:

B: This result is of questionable qualitative significance since this constituent was detected in blank(s) at similar concentrations.  
N/A : NOT ANALYZED  
All ERM data have gone through a quality assurance review.

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TABLE 4-23 (continued)  
**TYSON'S SITE**  
**FLOODPLAIN AREA SEDIMENT RESULTS (SURFACE WATER DISCHARGE AREAS)**  
**HBL ORGANIC COMPOUNDS**  
**MARCH, 1987**  
(mg/kg, dry wt. basis)

	FP-001 spring	FP-002 western ditch	FP-003 ponded area at stripper discharge	FP-004 eastern ditch
<b>Volatile</b>				
1,2,3-Trichloropropene	0.040		0.037	0.037
Methylene Chloride	0.061 B	0.034 B	0.056 B	0.016 B
Acetone	0.087 B		0.032 B	0.010 B
1,1,1-Trichloroethane	0.077	0.023	0.030	0.049
Tetrachloroethene	0.005		0.016	0.005
Toluene	0.013	0.022	0.110	0.014
Total xylenes	0.009		0.022	
Ethylbenzene			0.007 J	
Trichloroethene	0.007			
<b>Semi-volatile</b>				
Naphthalene	0.67	0.64		0.33 J
2-Methylnaphthalene	0.66	0.41 J		0.50 J
Acenaphthylene	0.27 J			
Dibenzofuran	0.43 J	0.54		
Acenaphthene	0.27 J			
Fluorene		0.72		
1,2,4-Trichlorobenzene			0.64	0.50 J
Phenanthrene	0.66	3.67		0.50 J
Anthracene	0.30 J	1.09		
Fluoranthene	1.06	4.66	0.32	0.50 J
Pyrene	0.96	5.01	0.48	0.58
Benzo (a) anthracene	0.50 J	3.34		
Chrysene	0.81	3.03		0.33 J
Benzo (b) fluoranthene	1.44	4.61		
Benzo (e) pyrene	0.43 J	2.62		
Indeno (1,2,3-cd) pyrene		1.40		
Benzo (ghi) perylene		1.49		
Dibenzo(ah)anthracene	0.27 J			
<b>PCB's and Pesticides</b>				
PCB-1254	0.048 J		0.14 J	0.042 J
PCB-1260			0.16 J	

Qualifier Codes:

J: This result should be considered a quantitative estimate.

B: This result is of questionable qualitative significance since this compound was detected in blanks(s) at similar concentrations.

All ERM data have gone through a quality assurance review.

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TABLE 4-23 (continued)  
TYSON'S SITE  
FLOODPLAIN AREA SEDIMENT SAMPLES (SURFACE WATER DISCHARGE AREAS)  
TENTATIVELY IDENTIFIED COMPOUNDS  
March, 1987  
(all concentrations estimated in mg/kg)

	FP-001 spring	FP-002 western ditch	FP-003 ponded area at stripper discharge	FP-004 eastern ditch
total aliphatic hydrocarbons	2.7 J	3.1 J		0.5 J
total unknowns	20.9 J	5.7 J	7.7 J	3.8 J
methyl-benzenesulfonamide isomers			0.97 J	0.80 J
hexadecanoic acid	0.93 J	2.9 J	0.17 J	1.3 J
1-methyl naphthalene	0.60 J			0.4 J
dimethyl naphthalene isomer	1.2 J			
tetradecanoic acid	0.575			
a methyl phenanthrene isomer		7.6 J		
9,10-anthracene diene		0.77 J		
12-methyl benzo(a) anthracene		0.73 J		

J. This result should be considered a quantitative estimate.

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TABLE 4-24  
TYSON'S SITE  
FLOODPLAIN AREA SURFACE WATER SAMPLES (DISCHARGE AREAS)  
INORGANIC CONSTITUENTS  
March, 1987  
(concentrations in mg/L, ppm)

CONSTITUENT	FP-001 spring	FP-002 western ditch	FP-003 ponded area at stripper discharge	FP-004 eastern ditch	FP-011 blind blank	FP-A FP-004 filtered	FP-B FP-003 filtered	FP-C FP-002 filtered	FP-D FP-001 filtered	FP-E duplicate FP-A
ALUMINUM		0.2 B	0.2 B	0.1 B		0.1	0.1	0.1	0.1	0.1
BARIUM	0.1	0.2	0.1		0.04					
COPPER										
IRON	0.08	0.22	1.60	0.21			0.64		0.04	
MANGANESE	0.03	0.01	0.19	0.01			0.20		0.03	
ZINC			0.02 B	0.03 B		0.02 B	0.02 B		0.04 B	0.03 B

Blank = none detected

B: This result is of questionable qualitative significance since this constituent was detected in blanks at similar concentrations.  
All ERM data have gone through quality assurance review.

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TABLE 4-24 (continued)  
**TYSON'S SITE**  
**FLOODPLAIN AREA SURFACE WATER RESULTS (DISCHARGE AREAS)**  
**HSL ORGANIC COMPOUNDS**  
**MARCH, 1987**  
(Concentration in mg/L)

	FP-001 spring	FP-002 western ditch	FP-003 ponded area at stripper discharge	FP-004 eastern ditch	FP-011 blind blank
<b>Volatile</b>					
1,2,3-Trichloropropane	0.129	0.002 B	0.098	0.013	
Trichloroethene	0.009				
Methylene Chloride				0.008 B	
<b>Semi-volatile</b>					
None detected					
<b>PCB's and Pesticides</b>					
None detected					
<b>Tentatively Identified Compounds</b>					
<b>volatile</b>					
Unknown				0.074 J	
<b>semivolatile</b>					
Oxirane, (chloromethyl)-			0.009 J		
Unknown			0.006 J		
1-Propanol, 2,3-dichloro-			0.086 J		
Urea, tetramethyl-			0.009 J		
Unknown	0.035J		0.007 J	0.005 J	
Unknown	0.046J		0.095 J	0.005 J	
Unknown	0.130J		0.011 J	0.006 J	
Unknown	0.011J		0.006 J		
2H-pyrano(2,3-c)- pyridine, 8-methyl-			0.007 J		
Unknown			0.015 J		
Unknown			0.09 J		
Unknown			0.13 J		
Unknown			0.13 J		
Unknown			0.007 J		
Tribromo phenol isomer	0.036BI	0.031BI	0.016	0.042	

**Qualifier codes:**

B: This result is of questionable qualitative significance since this compound was detected in blank(s) at similar concentrations.

J: This result should be considered a quantitative estimate.

Blank = none detected

ND: None detected

All ERM data have gone through a quality assurance review.

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TABLE 4-25  
 TYSON'S SITE  
 FLOODPLAIN AREA SEDIMENT SAMPLES  
 GRAIN SIZE DISTRIBUTION  
 APRIL 13, 1987

LOCATION	% Retained on #10	% Retained on #40	% Retained on #200	% Through #200
FP-001	30.0	26.5	34.5	9.0
FP-002	13.1	32.4	30.9	18.6
FP-003	0.4	30.4	36.2	33.0
FP-004	13.9	46.1	31.9	8.1
FP-005	1.7	27.6	44.1	26.6
FP-006	0.3	36.3	34.6	28.8
FP-007	0.3	30.8	39.5	29.4
FP-008	1.4	33.2	34.7	30.7
FP-009	1.9	36.6	41.3	20.2

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below 1 mg/kg. As per most sediment samples collected in the floodplain area, a suite of PNAs were reported at total concentrations approaching or exceeding 1 mg/kg. Estimated concentrations of PCB-1254 were reported in each of the sediment samples except for the sample from the western ditch. An estimated concentration of PCB-1260 was also reported in the sediment sample from the ponded area receiving the stripper discharge. No pesticides were detected in any of these sediment samples. The results of the grain size analyses for the sediment samples taken during March are provided in Table 4-25.

The results of the analysis of the surface water samples from locations FP-001 thru FP-004 are shown on Table 4-24. Table 4-24 also includes the results of inorganic analyses of both filtered and unfiltered surface water samples from each of the locations. Trace concentration of barium, iron, and manganese were reported in both the filtered and unfiltered samples from most of the locations. The iron concentrations were lower in the filtered samples. 1,2,3-trichloropropane was reported in surface water samples from the spring, ponded area receiving the stripper discharge, and the eastern ditch. Trichloroethene was detected (0.009 mg/l) in the spring water.

In June 1987, sediment and surface water samples were taken during low flow conditions at Weir #4 (Plate 7). Weir #4 is located downgradient of the discharge from the air stripper and was the only one of the three discharge areas with a measurable flow under these low flow conditions.

Table 4-26 provides the results of the sediment analysis for the sample taken at Weir #4. The metal concentrations are similar to

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TABLE 4-26  
TYSON'S SITE  
FLOODPLAIN AREA SEDIMENT SAMPLE RESULTS (DISCHARGE AREA)  
HSL ORGANIC COMPOUNDS  
(concentration in mg/kg, dry wt. basis)

SAMPLE	WEIR #4
DATE SAMPLE	6/17/87
<u>Volatile</u>	
Methylene Chloride	0.280 B
Acetone	0.068 B
Chloroform	0.011 J
<u>Semi-volatile</u>	
1,2-Dichlorobenzene	0.100 J
1,4-Dichlorobenzene	0.100 J
1,2,4-Trichlorobenzene	0.170 J
Phenanthrene	0.300 J
Fluoranthene	0.480 J
Pyrene	0.530 J
Benzo (a) anthracene	0.320 J
bis(2-ethylhexyl) phthalate	0.280 B
Chrysene	0.370 J
Benzo (b) fluoranthene	0.290 J
Benzo(k)fluoranthene	0.270 J
Benzo (a) pyrene	0.320 J
Indeno (1,2,3-cd) pyrene	0.170 J
<u>PCB's and Pesticides</u>	
Beta-BHC	0.031 NC
4,4'-DDE	0.079
4,4'-DDD	0.22

Qualifier Codes:

J: This result should be considered a quantitative estimate.

B: This result is of questionable qualitative significance since this compound was detected in blank(s) at similar concentrations.

NC: This result cannot be considered confident.

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**TABLE 4-26 (continued)**  
**TYSON'S SITE**  
**FLOODPLAIN AREA SEDIMENT SAMPLE RESULTS (DISCHARGE AREA)**  
**TENTATIVELY IDENTIFIED COMPOUNDS**  
(concentration in mg/kg ,dry wt. basis)

<b>SAMPLE</b>	<b>WEIR #4</b>
<b>DATE SAMPLED</b>	<b>6/17/87</b>
<b>VOLATILE COMPOUNDS</b>	
1-Propene	0.024
<b>SEMIVOLATILE COMPOUNDS</b>	
Hexadecanoic acid	0.40 J
Aliphatic hydrocarbon	52
Total unknowns	16.3 J

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TABLE 4-26 (continued)

TYSON'S SITE  
FLOODPLAIN AREA SEDIMENT SAMPLE RESULTS (DISCHARGE AREA)  
INORGANIC CONSTITUENTS  
(concentration in mg/kg; dry weight basis)

Sample Description	Weir #4
CONSTITUENTS	
Aluminum	7130
Arsenic	10 J
Barium	225 J
Beryllium	1.3
Calcium	2520
Chromium	31
Cobalt	19
Copper	71
Iron	18400
Lead	65 J
Magnesium	1850
Manganese	1060
Mercury	0.29
Nickel	26
Vanadium	18 J
Zinc	251
Percent Solids	42

ND=None detected

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those detected in the sediment samples obtained from this area in March 1987.

4,4'-DDE (.0079 mg/kg) and 4,4'-DDD (0.22 mg/kg) were reported in the Weir #4 sediment sample. Estimated concentrations of several semi-volatile and PNA organic compounds were also detected.

Table 4-27 provides the results of the analysis of the surface water samples taken from Weir #4 and the influent and effluent samples from the air stripper taken in June 1987. 1,2,3-trichloropropane was detected in all of the samples. Stripper influent (.017 mg/L), stripper effluent (0.18 and 0.15 (duplicate) mg/L) and at Weir #4 (0.014 mg/L). Carbon disulfide (0.0054 mg/L) was also reported at Weir #4.

The samples of the air stripper influent and effluent were taken after the unit maintenance was taken over by CIBA-GEIGY Corporation (February 1987). Prior to this time, maintenance of the unit was sporadic and often the unit would operate on bypass (direct discharge of water from the collection trench to the floodplain).

#### 4.6.4 Biological Studies

##### 4.6.4.1 Environmental Mobility of Organic Chemicals

The results of the environmental mobility analysis for organic chemicals in the Floodplain/Wetlands Operable Unit (Section 3.5.3) are given in Table 4-28. The organic compounds are:

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TABLE 4-27  
 TYSON'S SITE  
 FLOODPLAIN AREA WATER SAMPLE RESULTS (DISCHARGE AREA)  
 HSL ORGANIC COMPOUNDS  
 (Concentration in mg/L)

Sample Description Date Sampled	Stripper Effluent 6/17/87	Stripper Effluent Duplicate 6/17/87	Stripper Influent 6/17/87	Stripper Effluent Duplicate 6/17/87	Weir 4 6/17/87
<b>VOLATILES</b>					
Tetrachloroethene			0.0012 J		0.014
1,2,3-Trichloropropane	0.18	0.15	0.17	0.15	0.0054
Carbon disulfide					
<b>SEMI - VOLATILES</b>	ND	ND	NA	NA	ND
<b>PESTICIDE/PCBS</b>	ND	ND	NA	NA	ND
<b>TENTATIVELY IDENTIFIED COMPOUNDS</b>					
3,3-Dichloropropene	0.014 J	ND	ND	ND	ND

Qualifier Codes:

J - This result should be considered a quantitative estimate.  
 Blank and ND= None detected  
 NA - Not analyzed

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TABLE 4-28  
BIOACCUMULATION POTENTIAL FOR  
ORGANIC COMPOUNDS DETECTED DURING THE EPA ON-SITE AND ERM FLOODPLAIN INVESTIGATIONS.

COMPOUND	K <sub>OW</sub>	K <sub>OD</sub>	RANKING FOR BIOACCUMULATION
LOW BIOACCUMULATION POTENTIAL			
ENDOSULFAN I	2.00E+02	0.00E+03	77
ENDOSULFAN II	2.00E+02	0.00E+03	76
ACETONE	5.78E+01	2.20E+00	75
3-BUTANONE (TID)	2.60E+01	4.50E+00	74
VINYL CHLORIDE	1.70E+01	0.20E+00	73
METHYLENE CHLORIDE	1.02E+01	0.00E+00	72
LOW TO MODERATE BIOACCUMULATION POTENTIAL			
ANILINE		1.40E+01	71
PHENOL	3.00E+01	1.42E+01	70
2-METHYLPHENOL	0.33E+01	1.40E+01	69
4-METHYLPHENOL	0.33E+01	1.40E+01	68
N-NITROBIS(4-PROPYLAMINE	3.10E+01	1.50E+01	67
4-METHYL-2-PENTANONE		1.99E+01	66
2-HEXANONE		1.90E+01	65
1,1-DICHLOROETHANE	0.30E+01	3.00E+01	64
NITROBENZENE	7.40E+01	3.80E+01	63
CHLOROFORM	0.10E+01	4.40E+01	62
TRANS-1,3-DICHLOROPROPENE	1.00E+02	4.80E+01	61
CIS-1,3-DICHLOROPROPENE	1.00E+02	4.80E+01	60
1,2-DICHLOROPROPANE	1.05E+02	5.10E+01	59
CARBON DISULFIDE (TID)	2.00E+00	5.40E+01	58
BENZOIC ACID (TID)	7.40E+01	5.55E+01	57
TRANS-1,2-DICHLOROETHENE	1.23E+02	5.90E+01	56
BENZENE	1.35E+02	6.50E+01	55
1,2,3-TRICHLOROPROPANE		6.88E+01	54
2-CHLOROPHENOL	1.51E+02	7.30E+01	53
BOPHORANE	1.80E+02	8.70E+01	52
2,4-DIMETHYLPHENOL	2.00E+02	9.00E+01	51
1,1,2,2-TETRACHLOROETHANE	2.45E+02	1.18E+02	50
TRICHLOROETHENE	2.63E+02	1.28E+02	49
DIETHYL PHTHALATE	2.95E+02	1.42E+02	48
1,1,1-TRICHLOROETHANE	3.20E+02	1.52E+02	47
FLUOROTRICHLOROMETHANE	3.31E+02	1.59E+02	46
HEPTACHLOR EPOXIDE	4.50E+02	2.20E+02	45
O-XYLENE	1.02E+03	2.40E+02	44
TOLUENE	6.20E+02	3.00E+02	43
CHLOROBENZENE	6.00E+02	3.30E+02	42
TETRACHLOROETHENE	7.59E+02	3.64E+02	41
N-NITROBIS(4-PHENYLAMINE	1.35E+03	6.48E+02	40
2-METHYLNAPHTHALENE		7.12E+02	39
NAPHTHALENE	1.95E+03	9.40E+02	38
HIGH BIOACCUMULATION POTENTIAL			
ETHYLENEBENZENE	2.20E+03	1.10E+03	37
DIELDRIN	3.50E+03	1.70E+03	36
1,2-DICHLOROBENZENE	3.60E+03	1.70E+03	35
1,3-DICHLOROBENZENE	3.60E+03	1.70E+03	34
1,4-DICHLOROBENZENE	3.60E+03	1.70E+03	33
ACENAPHTHYLENE	5.10E+03	2.50E+03	32
BETA-BHC	7.80E+03	3.60E+03	31
ALPHA-BHC	7.80E+03	3.60E+03	30
GAMMA-BHC	7.80E+03	3.60E+03	29
ACENAPHTHENE	9.00E+03	4.60E+03	28
2-CHLORONAPHTHALENE	1.00E+04	4.80E+03	27
DELTA-BHC	1.40E+04	6.60E+03	26
FLUORENE	1.80E+04	7.30E+03	25
1,2,4-TRICHLOROBENZENE	1.80E+04	9.20E+03	24
HEPTACHLOR	2.60E+04	1.20E+04	23
PHENATHRENE	2.80E+04	1.40E+04	22

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TABLE 4-28 (continued)  
BIOACCUMULATION POTENTIAL FOR  
ORGANIC COMPOUNDS DETECTED DURING THE EPA ON-SITE AND ERM FLOODPLAIN INVESTIGATIONS.

COMPOUND	K <sub>OW</sub>	K <sub>OC</sub>	RANKING FOR BIOACCUMULATION
ANTHRACENE	2.80E+04	1.40E+04	21
FLUORANTHENE	7.00E+04	3.80E+04	20
PYRENE	8.00E+04	3.80E+04	19
ALDRIN	2.00E+05	8.80E+04	18
CHLORDANE	3.00E+05	1.40E+05	17
D,N-BUTYL PHTHALATE	3.80E+05	1.70E+05	16
BUTYL BENZYL PHTHALATE	3.80E+05	1.70E+05	15
CHRYSENE	4.10E+05	2.00E+05	14
BENZOAANTHRACENE	4.10E+05	2.10E+05	13
BENZOFUORANTHENE	1.15E+06	5.50E+05	12
BENZOFUORANTHENE	1.15E+06	5.50E+05	11
4,4'-DDD	1.80E+06	7.70E+05	10
INDENO(1,2,3-CD)PYRENE	3.20E+06	1.80E+06	9
BENZOGHPERYLENE	3.20E+06	1.80E+06	8
DIBENZO(A,H)ANTHRACENE	6.90E+06	3.30E+06	7
4,4'-DDT	8.10E+06	3.90E+06	6
4,4'-DDE	9.10E+06	4.40E+06	5
BENZO(A)PYRENE	1.15E+08	5.50E+06	4
PCB	1.40E+07	5.70E+06	3
BIS(2-ETHYLHEXYL)PHTHALATE	4.10E+09	2.00E+09	2
D,N-OCTYL PHTHALATE	7.40E+09	3.80E+09	1

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divided based upon their  $K_{OC}$  values into three categories: no, low to moderate, and high bioaccumulation potential.

Little or no bioaccumulation is predicted for six compounds in Table 4-28, based upon the  $K_{OC}$  values. These compounds prefer the aquatic and atmospheric media to soils or sediments. Thus, these compounds could migrate through the soil column to the ground water or runoff to surface waters. The low to moderate bioaccumulators have some sorption to soils and sediments, but most would preferentially be found in aquatic and atmospheric media. The compounds might sorb to the soils and/or bioaccumulate to varying degrees in aquatic and terrestrial animals. The third category, compounds with high bioaccumulation potential, is represented by compounds which tend to sorb to soils/sediments in preference to water and air. These compounds do not easily leach or volatilize and thus, are more readily available for bioaccumulation in fish and/or mammals. The PAHs, pesticides/PCBs, and phthalate esters are commonly detected in tissues of exposed fish or animals. These compounds have the potential to biomagnify in the food chain.

On this basis, analyses for the turtle fat and tissue, clam samples, and plant samples from the floodplain included Hazardous Substance List (HSL) volatiles, semi-volatiles (both base neutrals and acid extractables), pesticides/PCBs, and 1,2,3-trichloropropane. The HSL covers the compounds from Table 4-19 and additional compounds which might be potential bioaccumulators.

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#### 4.6.4.2 Bioaccumulation Studies

Table 4-29 is a summary of the HSL organic compounds detected in the turtle, clam, and plant samples collected for the bioaccumulation study. Inspection of Table 4-29 and the Quality Assurance report for these samples shows that many problems were encountered during the analysis of the samples which subsequently makes data interpretation difficult. Most of the problems are a result of the methods employed for sample storage, preparation, concentration, and analysis. At the time of this work the EPA methods for analyzing biological samples had not been fully developed. The analytical results of several biological samples suffered from serious matrix effects which required the reporting of high detection limits and questionable results by the laboratory. After an ERM data review it was deemed necessary to qualify all of the data reported with the exception of the PCB-1260 concentrations in the turtle fat tissue samples. Also, as discussed below, the presence or absence of particular compounds in the biological samples does not necessarily reflect their environmental occurrence or source.

Both the control(C) or upgradient turtle and downgradient or site turtle(S) had elevated PCB-1260 concentrations in the fat samples; 69,000 and 19,000 ug/kg, respectively. The source(s) of the PCB-1260 are unknown. The only confirmed detections of PCBs were noted in upgradient background samples (250 and 5200 ppb in soil) collected during the On-Site RI conducted by Baker. Much lower (less than 100 ppb) but unconfirmed concentrations of PCBs were reported in off-site samples also collected during the Baker investigation. One of the leachates generated for the additional sediment toxicity bioassays, discussed in Section 4.6.4.4,

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TABLE 4-29

COMPOUNDS DETECTED IN BIOLOGICAL SAMPLES, TYSON'S SITE  
OFF-SITE OPERABLE UNIT RI

Units ug/kg

Compounds	Turtle		Class		Impatiens	
	Muscle-C	Muscle-S	Fat-C	Fat-S	Seep	A.S.
methylen chloride	15 B	33 B	24 B	69 B	31 B	27 B
acetone	840 NV	1500 NV	1200 NV	5100 NV	980 NV	790 NV
carbon disulfide	10 J	11 J	ND	ND	ND	ND
chloroform	11 J	21 J	ND	600 J	16 J	44 J
2-butanone	8 B	14 B	ND	ND	13 J	23 B
benzene	14 J	37 J	ND	1500 J	6 J	84 J
toluene	3 B	3 B	ND	34 J	ND	5 B
bis (2-ethylhexyl)						
phthalate	250 H	ND	ND	ND	360 H	ND
benzoic acid	ND	ND	ND	120 H	50 H	140 H
benzyl alcohol	ND	ND	ND	250 J	200 J	ND
beta-BHC	ND	ND	ND	ND	410 J	1000 J
PCB-1260	ND	ND	69,000	19,000	18 NR	ND
% Lipids	0.40	0.65	71.9	77.2	0.31	0.29
S - site sample	AS - airstripper	ND - not detected	C - control sample	BP - Bridgeport		

## Qualifier Codes

- B - Result is questionable qualitative significance, compound was detected in laboratory blanks at similar concentrations.  
 J - Result considered a quantitative estimate - refer to quality assurance review.  
 NV - Results for acetone are invalid - acetone was used for decontamination of equipment.  
 NR - Result is not reliable - refer to quality assurance review.  
 H - Result is suspected unreliable since this compound is frequent lab contaminant - refer to quality assurance review for additional details.

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reported a PCB 1248 concentration of 3.5 ug/l. No quantifiable concentrations of PCBs were reported in any of the samples collected in the former lagoon area. However, it may be noted that trace levels of PCBs which themselves may not be detected/reported by a laboratory in environmental samples can be bioaccumulated to the levels which have been detected in the turtle fat sample.

Although a detailed pathologic examination could not be conducted on the frozen turtle specimens, the turtles were inspected for gross abnormalities. Neither turtle showed evidence of gross abnormalities (Appendix O).

No detectable concentrations of 1,2,3-trichloropropane; the predominant site contaminant and major component of the dense nonaqueous phase liquid present in the deep aquifer, were reported in any of the biological samples. The detection limit for the 1,2,3-trichloropropane was reported to be 5 ppb for these samples. However, as stated in the ERM data review, the extended period of sample storage prior to analysis may have resulted in losses of VOA analytes including 1,2,3-trichloropropane from the sample.

Because of excessive sample holding time by the laboratory, the reported results for volatile organic compounds (VOCs) cannot be regarded with any measure of confidence. The VOCs reportedly detected in tissue samples are common laboratory solvents and can easily adulterate samples stored for long periods. It may be noted in this context that no detections of trichloropropane, which is not a common laboratory contaminant, were reported in these samples.

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According to the Superfund Public Health Evaluation Manual (1986), the bioconcentration factors for VOCs are relatively low (benzene and chloroform are 5.2 and 3.75, respectively). Biomagnification of these compounds is of minimal significance.

It should also be noted that none of the major site-related HSL organic compounds (primarily polynuclear aromatics (PAHs)) were detected in a quantifiable concentration above the reported detection limits in any of the biological samples. PNAs can be efficiently metabolized by the liver to more polar compounds which are conjugated and rendered even more water soluble and are readily excreted. Some literature indicates that this metabolic activity is limited in shellfish. The absence of detectable PNAs in clam tissues may suggest that transport of these contaminants to sensitive habitats is minimal.

#### 4.6.4.3 Large Volume Acute and Chronic Bioassays

Soil samples were obtained from 3 locations and submitted to the Academy of Natural Sciences in Philadelphia for generation of leachate for use in the acute and chronic bioassays. Soils were sampled on two separate occasions for subsequent chemical analyses. On 28 July 1986, samples were collected at three locations (Plate 6). These were:

- 1000 feet west of the ice-house (off site-control)
- western swamp (area near are railroad signal tower)

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- air stripper outfall (immediate vicinity of the discharge pipe)

On 25 September 1986, a second set of samples was collected in the west swamp and air stripper outfall. Analytical results for both inorganic constituents and organic compounds are presented in Table 4-30 and discussed below.

#### Organic Compounds

The ice-house sample, which was collected approximately 2000 feet west of the Floodplain/Wetlands Operable Unit, contained a number of PAH compounds (excluding the estimated values) including: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, fluoranthene, phenanthrene, and pyrene. Excluding the estimated PAH concentrations, PAHs were not found in the air stripper outfall samples. Pyrene and Indeno (1,2,3-cd)pyrene were reported in one of the two samples taken from the western swamp area. The source of the PAH's in the ice-house sample (total PAH concentration of 9.26 mg/kg) may be the coal sediment washed from the anthracite region well to the north of the site. The Soil Conservation Survey (SCS) Soil Survey for Montgomery County states that the Rowland silt loam, which occurs in the floodplain of the Schuylkill River, does contain anthracite coal sediment.

Two substituted benzenes, 1,4-dichlorobenzene (1.8 mg/kg) and 1,2,4-trichlorobenzene (3.2 mg/kg) were detected in the July air stripper outfall sample.

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TABLE 4-30  
TYSON'S SITE  
FLOODPLAIN AREA SOIL RESULTS  
H&L INORGANIC CONSTITUENTS  
mg/kg, dry weight

Sample ID Date Sampled Parameter	W of Ice House (Background) SS-088* A	Western Swamp Area SS-087* A	Western Swamp Area SS-088* A	Air Stripper Outfall SS-088** A	Air Stripper Outfall SS-070 A
Aluminum	16800	9270	19400	14400	9900
Antimony					
Arsenic	6.5	26	14.8	16	11
Barium	80	240	149	880	245
Beryllium	0.7	0.8	0.74	3	1.02
Cadmium	0.18	0.6	0.55	0.98	0.28
Chromium	31	30	22.3	40	16.4
Cobalt	10	20	12.4	8	8.2
Copper	30	450	109	110	34.8
Iron	26600	30900	14800	25800	11800
Lead	66	160	124	652	65.2
Manganese	492	840	344	211	159
Mercury	0.13NV	0.8NV	0.6NV	0.36NV	0.41NV
Nickel	16	20	17.3	23	12.3
Selenium	0.78	28	2	2.3J	1.2
Silver	0.12NV	0.25NV		0.48	
Thallium					
Tin	108	408		208	
Vanadium	38	408	37.1	54	24.5
Zinc	112	127	205	3070	243
% Moisture	32.1	75.5			
pH	6.47	6.17		6.81	
TOX					
Data reported by	ERM, Inc.	ERM, Inc.	ERM, Inc.	ERM, Inc.	ERM, Inc.

A - Data taken from 8 December 1986 report

\* - Large volume composite

\*\* - Grab samples to obtain preliminary data

J - this analyte was also found in the method blank and is of questionable qualitative significance

NV - estimated value

NV - this result is not valid; the laboratory absorbance data indicated this concentration is below the detection capability

Blank indicates not detected

All ERM data has gone through a quality assurance review.

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TABLE 4-50 (Continued).  
TYSON'S SITE  
FLOODPLAIN AREA SOIL RESULTS  
HSL INORGANIC CONSTITUENTS  
mg/kg, dry weight

Sample ID	W of Ice House (Background) SS-068*	Western Swamp Area SS-067*	Western Swamp Area SS-069*	Air Stripper Outfall SS-069**	Air Stripper Outfall SS-070
Date Sampled	A	A	A	A	A
<b>Parameter</b>					
<b>VOLATILES</b>					
1,2,3-Trichloropropane				6.3	0.033
Methylene chloride	0.063B	0.11B	0.094B	0.13B	0.067B
Acetone	0.13B	0.24B	0.45B	0.27B	0.33B
Chloroform	0.006B				
Vinyl chloride					
1,1-Dichloroethane		0.020J			
trans-1,2-Dichloroethane		0.045J			
2-Butanone		0.040B	0.090B	0.04B	0.041B
Trichloroethane				0.04	
Tetrachloroethane				0.05	
Toluene		0.22J	0.02B	0.02B	
Chlorobenzene		0.26J	0.045J	0.09	0.012J
Ethylbenzene		0.57J	0.05J		0.012J
Total xylenes		1.6J	0.89J	0.4	0.076J
2-Hexanone			0.05B		
<b>SEMI-VOLATILES</b>					
Phenanthrene	1.8	0.80J			
Anthracene	0.30J				
Di-n-butyl phthalate	0.63B	1.9B			3.5B
Fluoranthene	1.8	0.80J			
Pyrene	1.8	0.8			
Benzo(a)anthracene	0.8B				
Benzo(b&k)fluoranthene	1.2				
Benzo(a)pyrene	0.74				
Benzo(ghi)perylene	0.30J				
Indeno(1,2,3-cd)pyrene	0.30J	1			
Chrysene	1				
1,3-Dichlorobenzene				0.5J	
1,4-Dichlorobenzene		1.0J		1.8	
1,2-Dichlorobenzene		0.80J		0.8J	
1,2,4-Trichlorobenzene				3.2	
<b>PESTICIDES and PCBs</b>					
4,4'-DDE		3.0M	1.34M		
4,4'-DDD		12.8M	8.59M		
Data reported by	ERM, Inc.	ERM, Inc.	ERM, Inc.	ERM, Inc.	ERM, Inc.

A - Data taken from 8 December 1986 report  
\* - Large volume composite  
\*\* - Grab samples to obtain preliminary data  
B - this analyte was also found in the method blank and is of questionable qualitative significance  
J - estimated value  
Blanks indicate not detected  
M - This pesticide result was confirmed by GC/MS.

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Excluding compounds detected in the method blanks five volatile organic compounds were detected in the air stripper outfall samples. 1,2,3-trichloropropane was found in both air stripper samples (0.033 mg/kg and 6.3 mg/kg). Trichloroethylene (0.04 mg/kg) and tetrachloroethylene (.05 mg/kg) were found in the initial air stripper sample along with total xylenes (0.4 mg/kg) and chlorbenzene (0.09 mg/kg).

Pesticides were found only in soil samples collected in the western swamp area. 4,4'-DDD concentrations were 8.59 mg/kg and 12.9 mg/kg; and, DDE concentrations were 1.34 mg/kg and 3 mg/kg.

#### Inorganic Constituents

Concentrations of inorganic constituents in soil samples taken from the west swamp (SS067, SS069), air stripper outfall (SS068, SS070), and ice-house (SS066), are presented in Table 4-30. Ranges and mean concentrations of these elements commonly reported for soils of the eastern United States are presented in Table 4-18. With the exception of zinc, copper, selenium, and lead, inorganic constituent concentrations were well within or below the commonly reported range. Zinc and lead levels in the initial sample (SS068) from the air stripper outfall were substantially higher than average levels. This is most likely attributable to anthropogenic sources of zinc and lead, however, these sources may not be related to activities at the Tyson's Site as high levels of zinc, 20-1200 mg/kg, and lead, 218-10,900 mg/kg, are commonly reported for similar areas of urban development (Preer et.al., 1980). Copper concentrations exceeded typical levels reported for soils of the eastern United States (Table 4-18) in the initial sample (SS067) obtained from

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the Western Swamp location; selenium exceeded typical levels in the September sampling at the Western Swamp. Elevated levels of these constituents, however, have been reported for similar organic rich soils (Pendias and Pendias, 1984).

Significant variations in the concentration of a number of these inorganic constituents including aluminum, zinc, lead, barium, chromium, copper, iron, manganese, nickel and vanadium were found to exist among sampling locations and between sampling dates. These variations are thought to be the result of the heterogeneity of the soils developing on the Schuylkill River floodplain. These soils, mapped as the Rowland series, exhibit wide variations in the organic matter content and the thickness and composition of the sediment layer existing at the soils surface (Smith and Soil Survey Staff, 1967). In areas high in organic matter e.g. western swamp, constituents strongly absorbed by organic matter such as copper and arsenic would be expected to accumulate (Pendias and Pendias, 1984). Both of these constituents were present at higher concentrations in the western swamp samples than in either the ice-house or air stripper samples.

With regard to the sediment layer, this layer is derived primarily from coal sediments washed from the anthracite regions of Pennsylvania, north of the sampling area. This layer is reported to vary in thickness from 1 to 3 feet, subsequently, variations in the amount of sediment present may significantly affect the concentrations of inorganic constituents. For example, coal sediments are typically high in iron, soil samples taken from areas with a thicker sediment cap would be expected to exhibit higher iron concentrations than those obtained from areas

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with a thinner sediment cap. Additionally, certain inorganic constituents are often closely associated with other constituents, such that high concentrations of one element occur in conjunction with high concentrations of others (Pendias and Pendias, 1984). This relationship is particularly true for nickel and manganese which are closely associated with iron. Note that in areas where iron concentrations are high, e.g. western swamp (SS067), nickel and manganese concentrations are also high.

#### Leachate Generation

Leachate generated from the composite sediment samples collected to the west of the ice-house (background), western swamp, and air stripper discharge ditch were used in acute and chronic flow-through bioassays using juvenile daphnia (Daphnia magna) and newly born fathead minnows (Pimephales promelas). The bioassays were conducted by the Academy of Natural Sciences of Philadelphia (Academy). A complete report on procedures and results of this part of the investigation are given in Appendix R.

In addition to the generated leachates, two additional samples were analyzed. These were the dilution water used in the bioassay and a sample of the reference toxicant water which consisted of dilution water plus the reference toxicant (sodium lauryl sulfate). Sample designations and sample descriptions are presented in Table 4-31. Analytical results for inorganic constituents, organic compounds and tentatively identified compounds for the leachate water samples are presented in Table 4-32.

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TABLE 4-31  
LEACHATE WATER LOG

<u>Sample #</u>	<u>Date Collected</u>	<u>Sample Description</u>
LW001	8/7/86	Dilution water
LW-002	8/7/86	Reference Toxic
LW-003	8/7/86	Leachate #1 derived from soil collected 1000' west of ice house.
LW-006	9/30/86	Leachate #2 - taken from from western swamp
LW-007	9/30/86	Leachate #3 - air stripper discharge

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TABLE 4-32

TYSON'S SITE  
LEACHATE WATER RESULTS  
HSL ORGANIC COMPOUNDS  
(concentration in mg/l, total concentrations)

	LW-001*	LW-002*	LW-003*	LW-006*	LW-007*
	Dilution Water	Reference Toxicant	Background	Western Swamp	Air Stripper
Volatiles					
Acetone	NV	NV	NV	NV	NV
2-Butanone	9 B	6 B	8 B	4 JB	4 JB
Total Xylenes				2 J	
Semi-Volatiles					
Di-n-butyl phthalate		8 J			
Pesticides					
DDE				0.08 J	
DDD				0.4	
DDT				0.1	0.2

B=This analyte was also found in the method blank

J=Estimated value.

Blank=none detected.

\*= Locations found on Plate 4.

Q= Did not pass the quality control criteria.

NV= Not valid.

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TABLE 4-32

TYSON'S SITE  
 LEACHATE WATER RESULTS  
 TENTATIVELY IDENTIFIED COMPOUNDS  
 (concentration in ug/l, all values estimated)  
 (continued)

	LW-001*	LW-002*	LW-003*	LW-006*	LW-007*
	Dilution Water	Reference Toxicant	Background	Western Swamp	Air Stripper
Benzene, 1,2- dimethyl				13	
Benzene, methyl					55 B
(Benzene, (1-methyl undecyl)					12
Z-9 octadecen-1-ol				61 B	84 B
Fatty alcohol	36.0 B	646.5	32.6		
Benzene, 1,1'-sulfonylbis	17.5				
Phthalate ester	10.8	33	46.2		
1,2-benzenedicarboxylic acid ester	10.7				
Benzene, 1,1'-sulfonylbis			16		
Hexadecanoic acid, butyl ester				11	
Total unknowns	77.5	38.9	81.9	13	40
Total aliphatic hydrocarbons	28.2	1088.1			10
Total chlorinated hydrocarbons				62	49

B= This analyte was also found in the blank.

\*= Locations found on Plate 4.

Blank= none detected.

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TABLE 4-32

TYSON'S SITE  
LEACHATE WATER RESULTS  
INORGANIC CONSTITUENTS  
(concentration in mg/l, total concentrations)  
(continued)

	LW-001*	LW-002*	LW-003*	LW-006*	LW-007*
	Dilution Water	Reference Toxicant	Background	Western Swamp	Air Stripper
Aluminum			6.7	0.2	0.7
Cadmium			0.019	0.01	0.005
Copper					0.04
Iron			5.36	0.36	0.35
Lead			0.01		0.005
Manganese			0.03	0.7	0.16
Zinc			0.09	0.04	0.09

Blank=none detected

\*=Locations found on Plate 4.

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Trace level concentrations of aluminum, iron, lead, manganese, and zinc were detected in the three leachates. The elevated aluminum and iron in LW003 may be due to the fine soil particles associated with this sample which significantly affected the daphnia bioassay due to turbidity in the leachate.

Unqualified HSL organic compounds detected were limited to DDD in Sample LW006 at 0.4 ug/l and DDT in Samples LW006 and LW007 at 0.1 ug/l and 0.2 ug/l, respectively. Ten tentatively identified compounds were detected in the five samples.

#### Acute and Chronic Bioassays

The bioassays were conducted at the Academy laboratories following established testing protocols. Leachate was generated following ASTM Method D-3987-85. Prior to use in the bioassay, the leachate was separated from the sediment by continuous flow centrifugation. The background sample leachate (LW003) was observed to be turbid after centrifugation.

Daphnia testing consisted of 21-day exposure to assess survival (acute) and reproductive (chronic) effects. The fathead minnows were exposed for a 7-day period to assess survival and growth effects.

The fathead minnows did not exhibit a significant difference in survival or growth in any test concentrations of the three leachates in comparison to the dilution water controls.

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Daphnia response was more variable, especially in the background leachate tests where the turbidity in the centrifuged leachate appears to have had an effect. It is believed that long-term exposure (more than 6 to 7 days) to the turbidity of the leachate was a factor in affecting the feeding of Daphnia in the test vessels. In retrospect a higher feeding regime should have been used. It is also possible that a chronic effect, emergent only after long-term exposure and independent of the turbidity, was present in the soil leachates. These alternatives could not be explored within the time constraints of the reporting requirement. The lack of any trend in the effects observed in the background sediment leachate testing supports the possibility of an interaction of turbidity and any potentially toxic material in the leachate.

The air stripper leachate was observed not to be visibly turbid. Test results indicated a 21-day LC50 (Lethal Concentration to 50 percent of the test organisms) of 78 percent leachate. Reproductive effects were observed in the lowest concentration tested (60 percent leachate).

The West Swamp leachate was more turbid than the air stripper leachate, but not as turbid as the background leachate. The acute toxicity, 21-day LC50 was 69.6 percent of the leachate and a chronic effect on Daphnia was observed at 60 percent leachate. The air stripper and West Swamp leachates had a similar toxicity to Daphnia. No acute or chronic effects were observed for fishes.

The recommended screen tests to be performed for establishing test concentrations are acute tests (48 hours for Daphnia and 96

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hours for fathead minnows). No acute toxicity was observed; therefore, high leachate concentrations were used anticipating no acute toxicity but possibly some chronic toxicity. In fact, significant acute and chronic toxicity were not seen until Day 13-14 in the Daphnia tests and none in the fish tests. If a toxicity exists, acute or chronic, long-term exposure of at least two weeks is necessary. The recommended screen tests were unfortunately inappropriate for predicting the observed effects.

Because of the excessive turbidity in the background leachate, it was difficult to differentiate the effects attributable to the turbidity from the potential toxicity. Due to this problem and other associated difficulties encountered with the methods employed, the additional bioassays discussed below were conducted.

#### 4.6.4.4 Additional Sediment Toxicity Bioassays

As discussed in Section 3.5.3.5 surface sediment samples were collected from seven locations (Plate 8) in the Floodplain Area for the additional sediment toxicity bioassays. The results of analysis of samples of these sediments are provided in Table 4-33.

In general, the results of these analyses are similar to those for samples from those general areas obtained during other phases of work in the floodplain area. Overall, the highest metal concentrations were detected in the samples from the air stripper discharge area and the DDT area. Site related organic compounds such as 1,2,3-trichloropropane, toluene, xylenes, 1,2,4-trichlorobenzene, and 1,4-dichlorobenzene were reported in

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TABLE 4-33  
TYSON'S SITE  
FLOODPLAIN AREA SEDIMENT SAMPLE RESULTS  
(SEDIMENT TOXICITY BIOASSAYS)  
HSL INORGANIC CONSTITUENTS  
(Concentration in mg/kg, dry wt. basis)

CONSTITUENTS	BA-001S	BA-002S	BA-003S	BA-004S	BA-005S	BA-006S	BA-007S
	gas tank ditch	air stripper	western swamp	signal tower ditch	western ditch	control	DOT area
Aluminum	5480	17100	18400	6410	11900	5120	14400
Arsenic	2.5	13.7	8.2	4.3	5.2	2.6	11.4
Barium	72.2	432	227	106	160	64.8	135
Beryllium	0.40 B	2.2	1.1	0.80	0.70	0.40 B	1.1
Chromium	9.4	27.3	27.4	13.4	14.7	10.2	21.2
Cobalt	4.0	16.4	19.2	6.0	6.5	2.5	10.6
Copper	20.1	98.4	49.3	28.3	24.5	12.7	109
Iron	8680	36100	20900	15800	15200	7850	20000
Lead	22.7	109	126	95.4	55.5	29.2	103
Manganese	229	409	1120	142	462	133	347
Nickel	5.3	21.9	21.9	10.4	8.2	8.9	13.3
Selenium	0.40 B	3	1.9	0.30 B	0.50 B	0.3 B	1.0 B
Vanadium	12.0	60	43.8	11.9	19.6	11.4	37.1
Zinc	77.9	1070	299	69.2	96.1	81.7	182
Cadmium		0.11	0.60	0.20	0.20		0.60
Thallium		3.3 B		0.60 B	1.0 B	0.80 B	1.6 B

Qualifier Codes:

B: This result is of questionable qualitative significance since this constituent was detected in blanks(s) at similar concentrations.

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TABLE 4-53 (continued)  
TYSON'S SITE  
FLOODPLAIN AREA SEDIMENT SAMPLE RESULTS  
(SEDIMENT TOXICITY BIOASSAYS)  
HSL ORGANIC COMPOUNDS  
(Concentration in mg/kg, dry wt. basis)

	BA-001S 8/11/87	BA-002S 8/11/87	BA-003S 8/11/87	BA-004S 8/11/87	BA-005S 8/11/87	BA-006S 8/11/87	BA-007S 8/11/87
	gas tank ditch	air stripper	western swamp	signal tower ditch	western ditch	control	DOT area
<b>COMPOUNDS</b>							
<b>VOLATILES</b>							
1,2,3-Trichloropropane	0.017	0.085	0.183	0.007			
Methylene chloride	0.004 B	0.016 B		0.027 B	0.007 B	0.004 B	
Acetone	0.024 NV	0.44 NV	0.030 NV	1.000 NV	0.082 NV	0.025 NV	0.270 NV
trans- 1,2-Dichloroethane		0.071		0.019			
2-Butanone		0.110		0.010 J	0.010 J		0.053
Trichloroethane				0.009			
4-Methyl-2-pentanone		0.055					
Tetrachloroethane	0.004 J		0.011 J	0.004 J			
Toluene		0.980			0.003 B		0.110
Chlorobenzene		0.280					0.053
Ethylbenzene		0.490					0.110
Total xylenes		7.100		0.021			1.000
Vinyl chloride		0.016 J					
Benzene		0.011 B					
Chloroethane						0.004 J	
<b>SEMI-VOLATILES</b>							
1,2,4-Trichlorobenzene		3.10					
1,2-Dichlorobenzene		2.00 J					0.80 J
1,4-Dichlorobenzene		3.60					
4-Methylphenol		14.00			1.30		
Benzo (a) anthracene				0.30 J	1.35	0.38 J	
Benzo (a) pyrene	0.26 J				1.14	0.38 J	
Benzo (b) fluoranthene	0.26 J			0.30 J	2.17	0.80	
Chrysene	0.40 J			0.45 J	1.47	0.81	
Fluoranthene	0.67			0.85	3.26	1.11	0.53 J
Phenanthrene	0.71			0.84	2.28	0.80	0.53 J
Pyrene	0.53			0.84	2.45	0.80	
1,3-Dichlorobenzene		1.09 J					
Benzoic acid		1.83 J					
Naphthalene				0.30 J	0.33 J		
2-Methyl naphthalene				0.30 J	0.49 J		
Benzo(k)fluoranthene				0.30 J			
2,4-Dimethylphenol					0.33 J		
Dibenzofuran					0.33 J		
Fluorene					0.33 J		
Anthracene					0.49 J		
Indeno(1,2,3-cd)pyrene					0.49 J		
Benzo(ghi)perylene					0.49 J		
Dibn-butyl phthalate							0.53 B

**Qualifier Codes:**

J: This result should be considered a quantitative estimate.

B: This result is of questionable qualitative significance since this constituent was detected in blank(s) at similar concentrations.

NV: The results for acetone are not valid if it was used for a decontamination solvent.

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TABLE 4-33 (continued)  
 TYSON'S SITE  
 FLOODPLAIN AREA SEDIMENT SAMPLE RESULTS  
 (SEDIMENT TOXICITY BIOASSAYS)  
 HSL PESTICIDES  
 (Concentration in mg/kg, dry wt. basis)

COMPOUNDS	BA-001S	BA-002S	BA-003S	BA-004S	BA-005S	BA-006S	BA-007S
	5/11/87 gas tank ditch	5/11/87 air stripper	5/11/87 western swamp	5/11/87 signal tower ditch	5/11/87 western ditch	5/11/87 control	5/11/87 DDT area
DDD		0.279	3.26				2.12
DDE			1.56				1.11
DDT			0.123			0.013 J	0.42
PCB-1254				0.150 J	0.300		
PCB-1260					0.64		

Qualifier Codes:

J: This result should be considered a quantitative estimate.

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TABLE 4-33 (continued)  
TYSON'S SITE  
FLOODPLAIN AREA SEDIMENT SAMPLE RESULTS  
(SEDIMENT TOXICITY BIOASSAYS)  
TENTATIVELY IDENTIFIED COMPOUNDS  
(concentrations in mg/kg)

[illegible]

**Overseer Code:**

**f. This must should be considered a quantitative estimate.**

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TABLE 4-33 (continued)  
TYSON'S SITE  
FLOODPLAIN AREA SEDIMENT SAMPLE RESULTS  
(SEDIMENT TOXICITY BIOASSAYS)  
GENERAL PARAMETERS  
(concentration in mg/kg)

ITEM	UNIT	BA-001S 5/11/87	BA-002S 5/11/87	BA-003S 5/11/87	BA-004S 5/11/87	BA-005S 5/11/87	BA-006S 5/11/87	BA-007S 5/11/87
		gas tank ditch	air stripper	western swamp	signal tower ditch	western ditch	control	DOT area
Moisture	% by wt.	25.2	81.7	63.5	32.9	38.7	21.3	62.3
TOC	mg/kg as received	3300	11000	9700	6400	14000	2300	11000
TOC	mg/kg dry wt. basis	4400	60000	27000	9500	23000	2900	29000
pH	1:1	7.75	6.77	7.03	7.18	6.95	6.97	6.82
Particle Size-mesh 4	% passing	85.79	99.97	98.89	99.46	98.22	99.93	99.03
Particle Size-mesh 8	% passing	75.13	99.62	98.36	97.80	98.75	97.47	98.55
Particle Size-mesh 50	% passing	33.25	98.84	93.50	65.79	81.19	27.87	90.07
Particle Size-mesh 200	% passing	26.70	90.15	83.62	45.85	64.83	22.49	79.52

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samples from the air stripper discharge areas and the west swamp, signal tower ditch and DDT area which all receive surface water discharges from the former lagoon area. 1,2,3-trichloropropane (.017 mg/kg) was reported in the gas tank ditch to the east of the air stripper discharge areas. A similar concentration was reported in the sediment samples from this area described in Section 4.6.4.4. PNAs were detected for the west swamp. Only estimated concentrations of PNAs were reported in the DDT area and the air stripper discharge area.

Elevated concentrations of DDD, DDE, and DDT were reported in the samples from the west swamp and DDT area. These two areas are adjacent to each other and may reflect a common source. As stated previously, these pesticides are not present in the former lagoon area. No pesticides were found in the sediment samples taken from the discharges to the river described in Section 4.6.4.4. DDD was also detected (0.279 mg/kg) in the air stripper discharge area. PCB-1254 and PCB-1260 were detected at 0.30 mg/kg and 0.64 mg/kg, respectively, in the western ditch which does not receive runoff from the former lagoon area. No PCBs were reported in a sediment sample taken from this areas as part of the discharge to the river study; Section 4.6.4.4. An estimated concentration of PCB-1254 (.015 mg/kg) was reported in the signal tower ditch sample.

Table 4-33 also includes the results of the % moisture, TOC, and grain size analysis of the sediment samples. As noted, those parameters vary greatly for the seven sediment samples.

Results of the 48-hour liquid phase elutriate test indicated no mortality in any of the 21 test chambers or triplicate dilution

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water controls. The results suggest that the site sediment elutriates tested do not have an acutely toxic potential to Daphnia.

Results of the 48-hour survivorship tests using 5-day old Daphnia in the solid phase sediment and water beaker test indicate one (1) death in the control sediment (Sample 6) triplicate sample.

The ten (10) day adult survivorship test using the solid phase sediment and water beaker test showed that surviving adults did not display a significant difference ( $P > 0.918$ ) among the chambers containing the test sediment samples, control sediment sample, and dilution water control. Total number of animals counted were:

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Station	Total Daphnia	Range
1 Gas Tank Ditch	1107	303-419
2 Air Stripper	1916	583-718
3 West Swamp	950	221-382
4 Signal Tower Ditch	1422	442-490
5 West Nest 4 Ditch	1945	597-722
6 Control Sediment	1914	566-714
7 DDT Suspect Area	1228	307-474
8 Dilution Water - Schuylkill River	1618	452-601

Significant differences were observed, however, among the total number of animals (surviving adults plus progeny) at the end of 10 days of exposure compared to the control soil samples. Samples 1 (1107 Daphnia), 3 (950 Daphnia), and 7 (1228 Daphnia) had significantly fewer animals than the control soil (1914 Daphnia).

Comparing samples 1, 3, and 7 to the river water control (1618 Daphnia) indicated that samples 1 and 3 were significantly different.

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Differences in the control sediment (1914 Daphnia) and the river water control (1618 Daphnia) may be due to nutrient (phosphorous and nitrate) stimulation of the algae during the test.

A summary of the quality assured analytical data of both studies is presented in Tables 4-34 and 4-35. Also included are USEPA ambient water quality criteria, and several lowest observed effects levels.

Results of the liquid phase elutriate chemical analysis indicate no potential acute toxicity based on chemical analysis. The LOEL value for 1,2,3-trichloropropane is at least 1000 times more than the highest concentration detected of 1,2,3-trichloropropane. Two metabolites of DDT, DDE and DDD were detected in the swamp sample (3) at concentrations of less than part per billion.

Analytic results of the solid phase sediment and water beaker test were more variable. Sediments 2, 4, 5, 6, and 7 leachate exceed the chronic criteria for iron. Only one of the iron analytical data is not a quantitative estimate. Sediment 2 had an estimated 16 mg/l iron, however sediment 2 leachate supported the same number of Daphnia as the control sediment.

Iron concentration differences in the two types of leachate may be due to conditions established in the test chambers during the three-day settling period in the water beaker test.

The PCB-1248 concentration in Sediment 3 leachate exceeded both the chronic and acute criteria. Sediment 3 leachate also had the lowest total number of Daphnia at the end of the test period. No PCBs were detected in the liquid phase elutriate of sediment 3 or

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TABLE 4-34  
ANALYTIC RESULTS - SEDIMENT BIOASSAY  
LIQUID PHASE ELUTRIATE METHOD  
mg/l

Station No. Description	1	2	3	4	5	6	7	8	Water Quality Criteria For Protecting Aquatic Life (a)	
	Gas Tank Ditch	Air Stripper	West Swamp	Signal Tower Ditch	Western Ditch	Control	DDT Area	Schuyler River	Acute	Chronic
Aluminum										
Barium	0.2	0.2		0.1	0.3	0.2	0.2	0.1		
Iron		0.87J	0.43J	0.35J	0.57J	0.1	0.2			
Manganese	1.35J	0.65	0.02	0.68	3.75	0.18J	4.9J	0.25J	1.0	
Zinc	0.048	0.028	0.028	0.018	0.028	1.55	1.38	0.05		
1,2,3-Trif- chloropropane	0.012	0.075	0.028	0.029		0.028	0.038	0.018	0.32	0.047
Chloroform									42.0 LOEL <sup>b,c</sup>	
Total Xylenes	0.0038	0.011	0.0038	1.0028		0.0028			28.9 LOEL	1.24 LOEL
1,4-Dichloro- benzene		0.006J				0.004J			1.12 LOEL	0.765 LOEL
1,2-Dichloro- benzene		0.005J							1.12 LOEL	0.765 LOEL
Butylbenzyl phthalate			0.0038						0.94 LOEL	0.003 LOEL
DOE			0.00005J						1.05 LOEL	
DDO			0.0001						0.0011	0.000001

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B - This result is of questionable qualitative significance since this consultant was also detected in blank(s).  
J - This result should be considered a quantitative estimate.

a. Source: USEPA 1986 Quality Criteria for Water

b. Lowest Observed Effects Level

c. Source: USEPA 1985 Chemical and Physical Properties of Compounds Present at Hazardous Waste Sites

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TABLE 4-35  
ANALYTIC RESULTS - SEDIMENT BIOASSAY  
SOLID PHASE SEDIMENT AND WATER BEAKER TEST  
ug/l

Station No. Description	1	2	3	4	5	6	7	8	Water Quality Criteria For Protecting Aquatic Life (a) Acute	Chronic
Gas Tank Ditch				Signal Tower	Western Ditch	Control	DDT Area	Schuykill River		
Aluminum	0.1	0.1	0.2		0.2	6.6			0.36	0.19
Arsenic		0.011								
Barium	0.2	0.4		0.2	0.2	0.1			0.16	0.011
Chromium							0.01			1.0
Iron	0.63	16.41	0.421	5.151	1.651	1.51	1.41			
Manganese	0.54	0.67	0.18	0.76	2.84	2.79	0.64			
Zinc	0.048	0.208	0.028	0.028	0.02	0.068			0.32	0.047
1,2,3-Trichloro- propane	0.005	0.0041	0.018	0.005					42.0 LOEL <sup>b,c</sup>	
Toluene		0.009							17.5 LOEL	
4-Methyl-2- Pentanone		0.0021							0.25 LOEL	LOEL
Chlorobenzene		0.0021							32.0 LOEL	
Ethylbenzene		0.0021							10.2 LOEL	2.56 LOEL
Total Xylenes		0.032							1.12 LOEL	0.763 LOEL
Phenol		0.0081							1.12 LOEL	0.763 LOEL
1,4-Dichloro- benzene		0.0071							0.94 LOEL	0.003 LOEL
1,2-Dichloro- benzene									0.0011	0.000001
4-Methylphenol		0.100							0.002	0.000004
Bis(2-ethyl hexyl)phthalate		0.0068								
DDO			0.0002				0.0002			
PCB 1248			0.0035							

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B - This result is of questionable qualitative significance since this consultant was also detected in blank(s).  
: - This result should be considered a quantitative estimate.

a. Source: USEPA 1985 Quality Criteria for Water  
b. Lowest Observed Effects Level  
c. Source: USEPA 1985 Chemical and Physical Properties of Compounds Present at Hazardous Waste Sites

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any other sediment in both test types. Sediment 3 leachate also had sub-part per billion DDD levels as did sediment 1. PCBs are not site related compounds as they have not been reported in samples taken from the former lagoons.

Based on chemical analysis, 10 day effects on survival and reproduction on Daphnia in Sediment 3 (west swamp), and Sediment 7 (DDT area) may be related to the metabolites of DDT. Sediment 1 (gas tank ditch) supported to second lowest total number of Daphnia. None of the chemical parameters measured on Sediment 1 can be suggested as the toxic agent. As with the PCBs, the pesticides are not considered site related compounds as they have not been reported in samples taken from the former lagoons. A complete report on these additional bioassays is provided in Appendix S.

#### 4.7 Comparison of Organic Compounds Detected in On-Site and Off-Site Samples

An extensive data base exists for the organic compounds and inorganic constituents in the former lagoon area. This includes analysis of subsurface and surface soil samples obtained during the On-Site RI, (Appendix A), the Woodward Clyde Consultants Supplemental Soil Investigation (Appendix B), and the SRW investigation of the area west of the former lagoon area (Appendix C). Surface and subsurface soil and sediment and surface water samples from several of the Off-Site areas were also collected during the On-Site RI.

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Table 4-36 is a comparison of the organic compounds detected in the former lagoon areas during the above investigations and the organic compounds detected in the Off-Site Operable Units during the On-Site RI and the Off-Site Operable Unit RI. A broad suite of similar organic compounds were detected in both the former lagoon areas and the various Off-Site Operable Units. However, it is also quite obvious from Table 4-20 that the PAHs detected during the various investigations did not originate from the former lagoons.

Possible sources of the PAHs to the Off-Site Operable Units include the following:

- coal fines washed downriver from coal crushing/washing and storage operations along the northern reaches of the river;
- burning of construction materials;
- bottom ash used as fill material for the railroad ballast;
- materials used for maintenance and construction of the railroad;
- spills of coal, coal related products, and chemicals during the transport of these materials via the railroad;
- fly ash and gaseous emissions from the coal fired generating station on Barbadoes Island.

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## SECTION 5

### DATA CONSIDERATIONS

The Tyson's Site Off-Site Remedial Investigation (RI) sampling program included the collection of quality control samples such as blanks, duplicates, and samples for use in matrix spike analysis. These additional samples were collected for all sample matrices: soil, sediment, surface water, and ground water. Separate samples were collected for each matrix for duplicate and matrix spike samples for the following reasons:

1. To insure sufficient volume of sample for the laboratory to perform the required duplicate and matrix spike analyses specified in the analytical methods.
2. To allow ERM project management to select the specific samples to be used for analytical quality control. If the selection of the sample for duplicate and matrix spike analysis were left to the laboratory's discretion, the chosen sample may be from outside the study area, bearing no resemblance to the characteristics of the area of interest. Additionally, laboratories will typically select the "cleanest" samples for duplicate and spike sample analysis, providing little resemblance to true matrix effects exhibited by more representative environmental samples.

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3. To allow the generation of precise and accurate information specific to the samples collected at the Tyson's Site.

Inorganic constituents for the quality control (QC) samples were analyzed in duplicate; a single matrix spike was also analyzed. Quality control samples were analyzed as matrix spike duplicates for the organic analyses. Duplicate precision has been expressed as relative percent difference (RPD). Accuracy measurements from matrix spikes has been expressed as percent recovery. Field QC samples were submitted for every 20 samples, per fraction, per matrix, per day of sampling whichever was more frequent.

The analytical data summarized in this RI report have been validated by a qualified, quality assurance chemist with several years experience performing data validation for Superfund sites. ERM's data validation has been performed for all data generated for this case. Table 5-1 presented the items examined during ERM's Quality Assurance Review. Appendix T presents these quality assurance reviews. All data that required qualification based upon the quality assurance reviews have been flagged appropriately in the analytical summary tables. All data that is not flagged with a qualifier code should be considered qualitatively and quantitatively confident as reported.

As with all projects involving the collection and analysis of an extremely large number of samples, minor problems are not uncommon. However, very few problems were encountered during the review of the entire data base that had anything more than slight

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TABLE 5-1

ITEMS REVIEWED DURING THE ERM DATA VALIDATION

<u>Areas Examined</u>	<u>Applicability</u> (organic, inorganic, both)
ERM and Laboratory Chain of Custodies (Traffic Reports, Field Notes, Etc)	Both
Laboratory Narrative and QC Summaries	
Holding Times	Both
Extraction/Digestion Logs	Both
Blanks - Field and Laboratory (accuracy)	Both
Instrument Tune	Organic
Standards	Both
Linearity	Both
Sensitivity/Stability	Both
Selectivity/Specificity	Both
EPA Criteria (SPCC & LCS)	Both
Variability of Technique (internal standards)	Organic
Analyte Breakdown	Organic
Analytical Sequence	Organic
ICP Interference	Inorganic
Control Standards	Inorganic
Samples	
Detection Limits - Validity	Both
Instrument Printouts	Both
ICP data	Inorganic
AA data	Inorganic
GC data	Organic
GC/MS data	Organic
Autoanalyzer data	Inorganic
Qualitative Identification	Both
Mass spectra	Organic
Pesticide/PCB Results	Organic
Tentatively Identified Compounds	Organic
Quantitative Reliability	Both
Calculations/Equations	Both
Matrix spikes (accuracy)	Both
Bias	
Matrix spike duplicates	Organic
Bias	
Accuracy & Precision	
Surrogate Spikes (accuracy)	Organic
Bias	
Duplicates (field and laboratory)	Both
Precision	
Representativeness	
Post-Digestion Spikes	Inorganic
Matrix effects	

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impacts on the data. All reporting errors identified during the review process have been corrected and Lancaster Laboratories has resubmitted results accordingly. The quality assurance reviews found in Appendix T provide in a report format all qualifications that should be considered for the data set to best be utilized. As part of the quality assurance review process, support documentation has been prepared to substantiate each qualifier presented in the report.

Samples were analyzed for the full Target Compound List (TCL) (formerly the Hazardous Substance List) including library searches for extraneous chromatographic peaks as per Contract Laboratory Program (CLP) protocols. Table 5-2 contains the detection limits for the TCL organic compounds and metal constituents analyzed for in water and soil/sediment samples. Detection limits varied for individual samples due to matrix interferences, soil and sediment moisture content, and high concentration of one or more constituents necessitating dilution. Thus, the limits presented in Table 5-2 should be considered the lower limits of detection for the parameters. Water matrices have been reported in concentration units of mg/l, and soils/sediments in mg/kg on a dry weight basis.

A system and performance audit of Lancaster Laboratories was conducted by ERM during the RI to demonstrate the validity of the analytical system. The results of the audits are presented as Appendix U.

The performance audit consisted of submission of ampule samples obtained from the EPA Environmental Monitoring and Support

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TABLE 5-2  
DETECTION LIMITS FOR ANALYSES CONDUCTED  
AT THE TYSON'S SITE

<u>TCL Volatiles</u>	<u>Water Limit of Detection (ug/l)</u>	<u>Soil/Sediment Limit of Detection (ug/kg)</u>
chloromethane	10	10
bromomethane	10	10
vinyl chloride	10	10
chloroethane	10	10
methylene chloride	5	5
acetone	10	10
carbon disulfide	5	5
1,1-dichloroethene	5	5
1,1-dichloroethane	5	5
trans-1,2-dichloroethene	5	5
chloroform	5	5
1,2-dichloroethane	5	5
2-butanone	10	10
1,1,1-trichloroethane	5	5
carbon tetrachloride	5	5
vinyl acetate	10	10
dichlorobromomethane	5	5
1,1,2,2-tetrachloroethane	5	5
1,2-dichloropropane	5	5
trans-1,3-dichloropropene	5	5
trichloroethene	5	5
dibromochloromethane	5	5
1,1,2-trichloroethane	5	5
benzene	5	5
cis-1,3-dichloropropene	5	5
2-chloroethylvinyl ether	10	10
bromoform	5	5
2-hexanone	10	10
4-methyl-2-pentanone	10	10
tetrachloroethene	5	5
toluene	5	5
chlorobenzene	5	5
ethylbenzene	5	5
styrene	5	5
total xylenes	5	5

Additional Volatiles

1,2,3-trichloropropane (TCP)  
TCP by special protocol

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TABLE 5-2 (continued)

<u>TCL Semi-Volatiles</u>	<u>Water Limit of Detection (ug/l)</u>	<u>Soil/Sediment Limit of Detection (mg/kg)</u>
N-nitrosodimethylamine	10	0.33
phenol	10	0.33
aniline	10	0.33
bis (2-chloroethyl) ether	10	0.33
2-chlorophenol	10	0.33
1,3-dichlorobenzene	10	0.33
1,4-dichlorobenzene	10	0.33
benzyl alcohol	10	0.33
1,2-dichlorobenzene	10	0.33
2-methylphenol	10	0.33
bis (2-chloroisopropyl) ether	10	0.33
4-methylphenol	10	0.33
N-nitrosodi-n-propylamine	10	0.33
hexachloroethane	10	0.33
nitrobenzene	10	0.33
isophorone	10	0.33
2-nitrophenol	10	0.33
2,4-dimethylphenol	10	0.33
benzoic acid	50	1.7
bis (2-chloroethoxy) methane	10	0.33
2,4-dichlorophenol	10	0.33
1,2,4-trichlorobenzene	10	0.33
naphthalene	10	0.33
4-chloroaniline	10	0.33
hexachlorobutadiene	10	0.33
4-chloro-3-methylphenol	10	0.33
2-methylnaphthalene	10	0.33
hexachlorocyclopentadiene	10	0.33
2,4,6-trichlorophenol	10	0.33
2,4,5-trichlorophenol	50	1.7
2-chloronaphthalene	10	0.33
2-nitroaniline	50	1.7
dimethyl phthalate	10	0.33
acenaphthylene	10	0.33
3-nitroaniline	50	1.7
acenaphthene	10	0.33
2,4-dinitrophenol	50	1.7
4-nitrophenol	50	1.7
dibenzofuran	10	0.33
2,4-dinitrotoluene	10	0.33
2,6-dinitrotoluene	10	0.33
diethyl phthalate	10	0.33
4-chlorophenyl phenyl ether	10	0.33
fluorene		0.33

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TABLE 5-2 (continued)

<u>TCL Semi-Volatiles</u>	<u>Water Limit of Detection (ug/l)</u>	<u>Soil/Sediment Limit of Detection (mg/kg)</u>
4-nitroaniline	50	1.7
2-methyl-4,6-dinitrophenol	50	1.7
N-nitrosodiphenylamine	10	0.33
4-bromophenyl phenyl ether	10	0.33
hexachlorobenzene	10	0.33
pentachlorophenol	50	1.7
phenanthrene	10	0.33
anthracene	10	0.33
di-n-butyl phthalate	10	0.33
fluoranthene	10	0.33
benzidine	80	2.6
pyrene	10	0.33
butyl benzene phthalate	10	0.33
3,3'-dichlorobenzidine	20	0.66
benzo (a) anthracene	10	0.33
bis (2-ethylhexyl) phthalate	10	0.33
chrysene	10	0.33
di-n-octyl phthalate	10	0.33
benzo (b) fluoranthene	10	0.33
benzo (k) fluoroanthene	10	0.33
benzo (a) pyrene	10	0.33
indeno (1,2,3-cd) pyrene	10	0.33
dibenzo (a,h) anthracene	10	0.33
benzo (ghi) perylene	10	0.33

TCL Pesticides/PCB

alpha BHC	0.05	0.008
beta BHC	0.05	0.008
delta BHC	0.05	0.008
gamma BHC - lindane	0.05	0.008
heptachlor	0.05	0.008
aldrin	0.05	0.008
heptachlor epoxide	0.05	0.008
endosulfan I	0.05	0.008
dieldrin	0.1	0.016
DDE	0.1	0.016
endrin	0.1	0.016
endosulfan II	0.1	0.016
DDD	0.1	0.016
endosulfan sulfate	0.1	0.016
DDT	0.1	0.016
endrin ketone	0.1	0.016
methoxychlor	0.5	0.08

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TABLE 5-2 (continued)

<u>TCL Pesticides/PCB</u>	<u>Water Limit of Detection (ug/l)</u>	<u>Soil/Sediment Limit of Detection (mg/kg)</u>
chlordane	0.5	0.08
toxaphene	1.	0.16
PCB-1016	0.5	0.08
PCB-1221	0.5	0.08
PCB-1232	0.5	0.08
PCB-1242	0.5	0.08
PCB-1248	0.5	0.08
PCB-1254	1.	0.16
PCB-1260	1.	0.16

Task 1 and 2 Metals

aluminum	200	100
antimony	60	30
arsenic	10	5.0
barium	100	50
beryllium	5	2.5
cadmium	5	2.5
chromium	10	5.0
cobalt	50	25
copper	50	25
iron	100	50
lead	50	25
manganese	15	7.5
mercury	0.5	0.25
nickel	40	20
selenium	10	5.0
silver	10	5.0
tin	500	250
vanadium	200	100
zinc	10	5.0
thallium	10	5.0

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Laboratory, Cincinnati, Ohio for analysis by Lancaster Laboratories. Ampule samples from each TCL organic fraction and each metal constituent were submitted. The results of Lancaster's analyses were tabulated and compared to the 95% confidence interval of the true values. Lancaster's results were in all cases within the 95% confidence interval, and commonly very near the reported true value. The system audit findings are discussed in Appendix U. The performance and system audit indicated that technical competence and proper laboratory practices exist at Lancaster Laboratories.

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## SECTION 6

### CONCLUSIONS

The conclusions drawn from the results of this ERM investigation and previously conducted EPA investigations are presented in this section. Although several of the Off-Site Operable Units are discussed individually and the entire Off-Site Area separately from the On-Site Area, there is a strong interrelationship among several of the Off-Site Units and the former lagoons. Additional discussion of the relationship among the former lagoons, the Deep Aquifer and the Floodplain/Wetlands Areas can be found in a previous response to EPA's Focused Feasibility Study (FFS) for the On-Site Area by CIBA-GEIGY's Consultants (September 1986) and the Comprehensive Feasibility Study submitted to EPA (June 16, 1987; ERM).

Preliminary conclusions presented in the response to EPA's FFS with regard to the site hydrogeology have been confirmed by the results of the Off-Site Operable Unit RI as follows:

- previous investigations have incorrectly characterized the hydrogeologic setting at the site,
- there is no on-site "surficial aquifer",

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- EPA has separated the site into on-site/off-site areas ignoring the comprehensive and interrelated nature of the problem and the need to define it at this level prior to proper evaluation and selection of an appropriate remedial alternative,
- virtually all of the present source of residual contamination is in the underlying and off-site bedrock occurring both as a dense non-aqueous phase liquid (DNAPL) in the bedrock and as a dissolved phase derived from the DNAPL in the ground water.

Conclusions based upon the results of this RI for each of the Operable Units are as follows:

Deep Aquifer (Operable Unit 1)

- the deep aquifer (bedrock flow system) between the former lagoons and the Schuylkill River is contaminated;
- the deep aquifer contamination exists in two forms: a dense non-aqueous phase liquid (DNAPL) and a dissolved phase derived from the DNAPL;
- DNAPL most probably entered the bedrock system via direct infiltration from the former lagoons which were situated directly on or in the highly weathered and fractured bedrock, and/or via the seeps along the bedrock outcrop north of the lagoons into the very

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permeable railroad ballast, with subsequent infiltration into the bedrock beneath the tracks;

- once in bedrock, the DNAPL flowed along the weathered bedding planes and fracture zones in the Lower Stockton Formation, and coated and penetrated the walls of the fractures and bedding planes;
- the DNAPL has migrated through the deep aquifer as far as the south bank of the Schuylkill River to depths as great as 140 feet, the extent of migration is currently under investigation;
- there is no evidence (nor would we expect based upon site hydrogeologic conditions) that the DNAPL is discharging via the deep aquifer directly to the river;
- at this site attempts to recover DNAPL by known recovery methods have been shown to be ineffective due to the physical and chemical nature of the DNAPL, attempts to recover DNAPL from bedrock elsewhere have also been shown to be ineffective (Feenstra and Cherry, 1986);
- presence of residual DNAPL will continue to generate a dissolved phase contamination in the deep aquifer;
- the present source of ground water contamination to the deep aquifer is the dissolution (dissolved phase) of the DNAPL in the bedrock;

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- the overall contribution of the four major DNAPL constituents (1,2,3-trichloropropane, xylenes, toluene, and ethylbenzene) via the contaminated lagoon soils is only about 3.7 percent of the total contaminant mass in ground water. On the other hand, about 96.3 percent of the contamination in the deep (bedrock) aquifer results from the DNAPL present in the deep aquifer;
- the monitoring well yields in the deep aquifer at the site are low (generally less than 1 gpm) and decrease with depth;
- the direction of ground water flow in the deep aquifer is northward towards the river;
- there is an upward flow gradient in the deep aquifer underlying the floodplain, as expected in the floodplain and ground water discharge zone associated with a major regional drainageway;
- this gradient shows that both the ground water and dissolved phase contamination is discharging to the river within the regional ground water flow system;
- field evidence shows that the bedrock flow system discharges to the floodplain deposits, however, the discharge rate is significantly less than the ground water flow rate within the deposits in the floodplain. This is indicated by the lack of detectable organic

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compounds in the wells completed in the floodplain deposits;

Schuylkill River

- low concentrations of site specific organic compounds were detected in three river sediment samples taken directly opposite the site;
- this contamination may be a result of ground water discharge (dissolved phase contaminants) or of direct runoff from the drainageways discharging through the Off-Site Area, including the discharges from the EPA installed air stripper;
- a suite of non-site related polycyclic aromatic hydrocarbons (PAHs) was detected in most of the sediment samples both upriver and downriver of the site and at far greater concentrations than those contaminants identified as originating from the former lagoons;
- the PAHs are a result of the ubiquitous distribution of coal fines washed downriver and deposited along the Schuylkill River floodplain from coal crushing/washing and storage piles along the northern reaches of the river;

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- there are three water treatment plant intakes on the Schuylkill River downriver of the Tyson's Site; PA American Water Company in Norristown about 2000 feet from the site and the Philadelphia Water Department intakes at the Belmont and Queen Lane treatment plants;
- confirming historical data, part per trillion concentrations of 1,2,3-trichloropropane were detected in both raw and treated water samples taken at all of the treatment plants and at the Bartram Park sampling station downriver of the Philadelphia intakes;
- apparently the existing treatment systems do not remove the 1,2,3-trichloropropane from the untreated water at the part per trillion level;
- the probable source of 1,2,3-trichloropropane in the river is contaminated ground water discharging from the deep aquifer to the river in the vicinity of the site.

Hillside Area (Operable Unit 2)

- compounds detected in the former lagoons were detected at trace levels in several of the samples collected in this area and indicate that overland flow and/or shallow ground water discharge from the fractured bedrock outcrop in this area occurred during operation of the lagoons;

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- the total volume of contaminated soil in the Hillside Area is minimal with depth to bedrock usually being one or two feet and with exposed bedrock present in much of the area.

Railroad Area (Operable Unit 3)

- a wide variety of organic and inorganic compounds were found throughout this area, both associated with the former lagoon areas and with the materials used for the railroad ballast, railroad construction, and transport of materials by the railroad.

Floodplain/Wetlands Area (Operable Unit 4)

- trace levels of site-related contaminants were detected in the ditches and drainageways receiving runoff from the site and discharge from the EPA installed air stripper;
- PAHs, which are not site related, are generally found at the highest concentrations of all organic compounds detected and with the greatest distribution;
- the source of the PAHs is most probably the coal fines which have been washed downriver and deposited on the floodplain;

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- non-site related trace level concentrations of PCBs and the pesticides DDD, DDE, and DDT were found at several locations in the floodplain;
- PCB-1260 was the only constituent confirmed in the species analyzed during the bioaccumulation study (no site-related compounds were confidently detected); since PCBs are environmentally ubiquitous, it would be unusual if two to ten year old aquatic animals did not accumulate them in their tissues;
- no acute or chronic effects were observed in the fish species studied; the results of the testing in Daphnia were inconclusive;
- results of the liquid phase elutriate chemical analysis and bioassay show no potential acute toxicity in Daphnia in the sediments studied;
- based on the results of the 10-day ecological study of sediment leachate effects on survival in Daphnia and analysis of leachate, a decrease in Daphnia reproduction in leachates generated from the sediments from the west swamp and DDT area may be due to metabolites of non-site related DDT; and
- no adverse effects on any organisms investigated during the biological studies could be attributed to site-related constituents.

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Seep Area (Operable Unit 5)

- eleven of the sixteen samples taken from this area had no detectable Hazardous Substance List (HSL) organic compounds. The highest single concentration of HSL organics detected consisted of non-site related PAHs,
- the origin of the seep remains unknown, but is probably related to shallow ground water flow in this area; the seep has not re-occurred since initial restoration of the area.

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